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Dissertação
Mestrado em Educação e Tecnologias Digitais

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Abstract

At the dawn of the Information Age, despite the slow digital integration of mainstream education for the XXI century in most of the world, there are already new trends in education using digital technology that are revolutionizing education as we know it. One of such is the Flipped Classroom, a blended learning model growing quickly throughout the education innovators in the US and around the world. Many claim this model teaches necessary XXI century skills for, and when applied correctly can help students learn faster and reach higher levels of learning. The Flipped Classroom is an education model that inverts the traditional classic teacher-centred classroom model upside down, into a student centred structure, where student use digital technology (or not) to learn the material for homework, usually in 10-15 minute videos, and use the class time for application of the material, usually using active learning and collaborative learning strategies.

The following qualitative research project offers a comprehensive theoretical qualitative exploration of the Flipped Classroom Blended Learning model involving a non-directive interview with ten educational specialists in the Flipped Classroom model, including teachers, professors, and instructional designers who have converted their instruction to this model and who believe this is the future of education. Each of the interviewees were interviewed via Google Hangouts and Skype. The purpose of the study was to identify the possibilities and limitations of a flipped learning classroom environment at of all levels, from elementary school to university. This study hopes to assist professionals in determining the value of flipped learning for any educational purpose, by helping teachers make a shift into XXI Century education based on research proven data, and effectively shift learning responsibility in ways that improve learner outcomes.

The nature of this study is fundamentally of informative character, exploring the possibilities and limitations of the Flipped Classroom teaching model specifically for teachers and educational professionals (as well as students and families) interested in teaching techniques and approaches to education that promote student learning in the XXI century.

Keywords: *Flipped Classroom, Flipped Learning, Blended learning, XXI century skills, Active learning, collaborative learning, digital technologies*

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1. Introduction

1.1 Contextualization

At the beginning of the Information Era, we are faced with a world where technological innovations have become the main vehicle for information and knowledge, by its ease and speed of transmission. Increasingly, the computer, tablets, and smartphones, are taking a greater proportion in the daily life of people, both on a personal level and professional. However, the integration of technologies in education has been has been a slow sector to adapt to new technological transformations. Some teachers and professionals of education has concluded that the traditional model of education is based on the needs of the twentieth century and that is no longer responding to the needs of the reality of the 21st century. A report drawn up in 2007 by the National Center for Education and the economy of the United States says that "our education and training systems were built for another season". (quoted in Siemens, 2008).

On the other hand, digital technologies in education have increased exponentially, particularly in the last ten years, and may even be said that are revolutionising the way we learn from. (Cohen, Eli, 2003) the evolution of technology and social software is significantly change not only the way students have access to the information and knowledge, but also the type of dialog of the students with the instructor and with each other. (Siemens, 2008) In accordance with Kenski, some of the innovations of the new digital technologies in education that have revolutionized the learning has been e-learning, blended learning, forms of that adopt the totally or partially the use of technologies in the room. (quoted in Trevelin et al, 2013)

The Blended Learning, a term increasingly often used in academic circles and corporate (Graham, Charles, 2004) is an alternative that arouses particular interest because, this incorporates the best of both worlds of e-learning and instructional design, with the human interaction of classroom instruction with the teacher as a guide and the students focused on their own learning. There are various models of Blended Learning. The focus of this study is the model of the inverted Classroom, known as the Flipped Classroom, emerges as a subcategory of B-learning, and has given much to speak in the world of education in the 21st century. This new teaching approach, created by professors pioneers in the US who sought an efficient way to expose the matter to their pupils, is a form of B- Learning.

According to Math teacher Katie Gimbar, normally only a part of the students attentive to the front of the room understand well the lesson; 5 % may be disregarded, 5% may have cognitive difficulties, and another minority may already know the matter or, or understand at first, and they want go ahead. View videos or interactive digital material created by the professor, allows each student contact the matter at its own pace, and can repeat as many times as necessary. The term Flipped Classroom is still recent and is a teaching approach so new and wide. Some regard it as just another way of talking about student-centered learning. Others view flipped classrooms as the most innovative approach to learning. And others see flipping as just another innovation that is in vogue in an information overloaded society. (Honeycutt, B., & Garrett, J., 2014)

1.2 Objectives and justification of the Study

This study intends to make a review of the literature on the Flipped Classroom Blended Learning Model, understand its definition and what its impact on education as we know it to an approach focused more on the student, and compare it with the perspective of teachers and schools that use and are implementing. To start the steps of research, the guiding question of analysis was:" What are the Possibilities and Limitation of the Flipped Classroom model?" Despite the big popularity of the Flipped Classroom, why is there relatively so little rigorous research that proves your success? The lack of rigorous research is a reason not to adopt this educational modality? As until now there are no scientific data which prove the efficiency of this approach, the best strategy is even put questions to specialists.

- What are the advantages and disadvantages of Flipped Classroom?
- How and what conditions are necessary to reverse the classroom with success?
- If the traditional model of education which already exists for one hundred years works, because paradigm change?
- The compute will replace the role of the teacher and the students in human beings become even more dependent on the technologies?
- What are the results of teachers and schools that have embraced with success this model?
- What conditions are required to implement correctly this model so as to maximize student learning?
- How is it that the founders have implemented this model and what they are doing at the moment?
- How much time it takes a teacher or school to reverse its classroom? It is possible to make a partial or gradual inversion?
- As applies to Flipped Classroom in the different disciplines? There are disciplines easier to reverse than others?
- The application of Flipped Classroom in Language Teaching- (English.)
- What are the future directions of this model?

1.3. Organization of Work

This study is divided into two parts, the first being theoretical, literary research on the Flipped Classroom and its contextualization in the history of education, which is the difference between the traditional classroom and the Classroom Inverted, who are the founders and who is using this model at the moment? What are the advantages and disadvantages for a teacher or school adopt this model of education? Why and how to implement this model? What are the results of rigorous research? As applies in different disciplines? What are the results of rigorous research? Which programs can be used to reverse the classroom? How is different from other methodologies chains?

1.4. Methodology

For this exploratory research, a descriptive qualitative approach was chosen, with the objective of clarifying and providing deeper understanding of the Flipped Classroom Blended Learning model. Thus, the guiding reasoning was characterized by the search to acquire and expand knowledge (Gil, 1999), versus finding and proving a hypothesis. As to the character, this study has constructivist nature, since it seeked to realize the full complexity of the social context (Yin, 2005), using the interviews for the data collection phase. To understand the possibilities and limits of the classroom more deeply, semi-directive interviews were conducted to some of the founders and important leaders in the Flipped Classroom teaching model. What is flipped Learning and how it applies in the classroom? Why and how to reverse the classroom more efficiently? What are the main obstacles? What are the different styles of classroom reversed? The benefits and limitations of the Flipped Classroom? What are scientifically proven as effective teaching methods are applied? All these issues will be analysed in depth throughout the study, to observe main patterns throughout all the experiences.

The idea is to bring a variety of experiences and insight to the table for the reader, observe tendencies and examples of what can be done with the Flipped Classroom model, through the different defined categories to then draw conclusions from the general patterns from all the interviewees.

2. Theoretical Background

2.1 Brief history of the use of technology in education

From the prehistoric times, humans have depended on the use of tools to be more efficient and effective at completing his tasks. The resulting achievements have caused profound effects on civilization. From the invention of fire, writing and the press, as well as the phone and the computer, each one caused its own technological revolutions that have affected the heart of society**.** (Bishop, 2013)

Education has gone through a great deal of evolution over the years. Since the beginning of human history, education of the majority of the population was informal, where knowledge and professions were taught from generation to generation.

However, teaching tools are not new to the XX century. The use of tools to support teaching goes back about 2,500 years. Before writing, the main form of teaching was done orally, by which people trusted the excellence of their memory to transmit stories and knowledge. The emergence of writing in the Western world, in fifth century Ancient Greece, offered a memory aid for the students memorize recitations theatrical performances of poetry.

The similarity between lecture and sermon suggests that the lecture dates back to ancient times. The lecture system predates the invention of the printing press, because before the mechanization of book printing, lectures were the only efficient method to transmit knowledge. The ideas of theologians and scholars were dutifully reproduced by scribes. In the 13th century, as the center of intellectual life moved from courts to monasteries to universities, professional scribes became the principal creators of books. As it had been since the ancient Egyptians, the printed work was the only way to accurately preserve human knowledge. While book printing in Europe dates back to the mid-fifteenth century, it was not until the mid-nineteenth century that fast, mechanized book printing turned print into a mass medium. (Mazur, 1997) Also, in 12 B.C India, the slate plates used to write were a source of inspiration for the blackboards chalks in European schools of the 18th century. (Bates, T, 2014) So at least until the XX century, lectures and note-taking were necessary for the transmission of knowledge. (Mazur, 1997)

Official mandatory education only exists since the XIX century, born from the need to train workers in factories of the Industrial Revolution. Classes were set up education and students would attend a formal class on a scheduled basis. (Robinson, 2001)

2.1.1. Evolution of Technology

Modern technology has had an especially powerful effect on human life, influencing changes in lifestyle, work, leisure, health, and also on education. (Moura, Adelina, 2010). Most of technologies were created for practical communication purposes and were adopted in the XX century as aids to teachers in the classroom, such as books, pen and paper. Many technological inventions were adopted education tools, in particular for oral communication, writing, later television and videos, more recently digital technologies such as Web 2.0,-computer networks, Online Learning Environments, LMS, E-learning, and social networks. (Bates, Tony, 2014)

There are two related movements that are combining to change the face of education- The Technological and the Free Software movement. The technological movement has

enabled the broadcasting – and subsequent amplification and duplication of information at an extremely low-cost. (Bishop, 2013)

The Technological Movement, started with the printing press in the 1400s, which contributed to the mass distribution of information, has continued to evolve at an ever-increasing rate. In the 1830s, the electronic telegraph was created, followed by the, wireless radio in the late 1800s and early 1900s. In the XX century, the television came about in the 1920s, computers in the 1940s, the internet in the 1960s, and the world-wide web in the 1990s.

Since these technologies have come about, the ideas that have been spread through channels, causing a second movement, the Free Software movement. While the technological movement made way for physical free and open flow of information, the second more s ideological movement seeks to remove the artificial, man-made barriers. (Bishop, 2013)

The second movement, which is certainly not limited to software, can be compared to the analogy of the Encyclopaedia Britannica, which has physically existed for nearly 250 years, and what is now Wikipedia. Although the content of the Encyclopaedia Britannica has existed digitally since 1981, it was not until the rise of Wikipedia in 2001 that free widespread access to encyclopaedic content became available worldwide. Thus, although the technology and digital content existed and were available, ideological roadblocks prevented this from happening. So the world's largest, most up-to-date encyclopaedia was not available until humanity had overcome these outdated ideologies. (Bishop, 2013)

Similarly, we are beginning to observe the effects of these two movements in education, especially in higher education. More significant advances in research have been made in the technological arena.

Research studies show that video lectures slightly outperform in-person lectures, while interactive online videos doing even better. Interestingly, online homework is just as effective as paper-and-pencil homework, and specifically designed intelligent tutoring systems have been shown to be just as effective as human tutors. (Bishop, 2013)

But alas, as the development of good educational systems can be prohibitively expensive, and limited financial budgets often speak louder. However, the Free Software ideological movement is also breaking down these financial barriers. In 2001, MIT was one of the first institutions to open a MOOC, with the OpenCourseWare (OCW) initiative. This gave open access to information that had previously only been available to students who paid over $40,000 a year of university tuition.

Following this trend, in 2006, the Khan Academy was founded by MIT alumni Salman Khan founded, with a library of over 3200 free videos and 350 practice exercises. The stated mission of the Khan Academy is to provide "a free world-class education to anyone anywhere."

This movement rapidly gained momentum. Inspired by Khan Academy, in 2011 Stanford professors Sebastian Thrun and Andrew Ng opened free access to their courses, including Artificial Intelligence courses attracting over 160,000 students. Soon after, Thrun left the university and founded Udacity. Ng also founded his own open online educational initiative, called Coursera with support from Stanford University. Later on, Princeton, the University of Pennsylvania, and the University of Michigan joined the Coursera partnership, which has expanded to 42 course offerings. MIT also and joined with

Harvard in a $60 million dollar venture, to create their own open educational initiative EdX. (Bishop, 2013)

Nevertheless, as online education is expanding, and becoming openly available for free, university tuition at brick-and-mortar schools are also rapidly rising. Tuition in major universities are becoming more expensive. For example, the University of California tuition has nearly tripled since 2000.

According to results from a recent study by Gillen et al., undergraduate student tuition is used to subsidize research. (Bishop, 2013). The main question being asked by both students and educational institutions is what students are getting for their money. This dissatisfaction is applying a certain pressure on physical academic institutions to improve and enhance the in-person educational experience of their students. Besides students are not the only ones demanding higher outcomes from educational institutions. There is also increasing pressure from accreditation institutions for XXI Century skills- For example to work in teams, to the Accreditation Board for Engineering and Technology (ABET) specifies outcomes that university graduates, such as "an ability to communicate effectively," and "an ability to identify, formulate, and solve difficult practical problems," as well as, "an ability to function on multidisciplinary teams." Many of these criterion are generally difficult to teach and assess effectively with informative lectures and closed form questions. (Bishop, 2013)

2.1.2. The beginning of Technological Integration in Education

So where did this vision of technological integration in education begin? Computers were initially applied in behaviourist modes in accordance with Skinner's work* (Ravenscroft 2001), emphasizing the teacher's control over what is learned and how it is to be learned. More recently, the use of technology within constructivist learning models has been more dominant, since it enables students to construct their own understanding. The most influential learning theories of the XX century, Skinner's behaviourism**,** Piaget's cognitive constructivism, and Vygotsky's and Bruner's social constructivism can all be facilitated through technology can all be. (Nichols, M, 2007)

Dr. Seymour Papert, a professor at the Massachusetts Institute of Technology, was one of the first to recognize the potential of technology changing the learning enterprise as we know it. During the 1960s, Papert developed Logo programming language and began introducing it to children, a project in collaboration with the renowned Swiss psychologist Jean Piaget. The Logo language enabled students to use the computer to take control of their learning environment, which was simple enough for those who did not yet have sophisticated mathematical understanding. In this way, they were able to write -- and debug -- programs that controlled the movements of a turtle robot, with minimal instruction. Papert stated in a 1970 interview with *Computer Decisions*, "With computers, there is a substantially bigger chance that you can lead the child with less effort into something he really likes doing. (Bates, Suzy, 2014)

Since the 1960's, the tools available have developed greatly and become widespread, while barriers to using technology have steadily diminished. Today's learning landscape includes an ever-increasing array of affordable digital tools, from personal computers and handheld devices to interactive whiteboards, digital video cameras, and a constantly expanding variety of Web 2.0 tools. (Bates, Suzy, 2014)

2.2. The Origins of the Traditional Model of Education

To understand the situation of education today, it is vital to understand its origins. There is no doubt that the institutions are a reflection of the times in which they were created. What often happens is that many societies thus become fixed over time in their original foundational structures and are unable to adapt to changes in the external environment. This is true, in particular to the roots of our modern educational system, because education today is still heavily influenced by institutional structures developed a century ago. Thus, we need to examine the extent to which our teaching paradigm is still fit for the digital age. (Fukuyama, cited in Bates, 2014)

According to Fukuyama, the model of official urban schools and universities, organized by age stratification, where students gathered in classes, and were regulated in units of time, was an excellent choice for an industrial society at the turn of the century. In effect, we still use the model of education that resembles a factory, which in large part continues to be our standard model until today. (Bates, 2014)

Professor Sugatra Mitra also advocates that the traditional format of the classroom of the public schools was designed for an economic model of the industrial revolution for the British Victorian Empire of the nineteenth century. Mitra describes this education system as a robust and well organised bureaucratic administrative machine, whose main goal was to educate students to gain the necessary skills to maximize productivity in factories. (Mitra, Sugatra, 2013) In this context, the machine that produces these people is the school, which educates people to become identical members of the bureaucratic administrative machine. The main competencies taught are reading, calligraphy, and mathematical calculation. For example, in this system, people should be so similar so that it would be possible to choose a person in New Zealand, send them to Canada, and these would be instantly functional. The Victorians designed a system so well that it is still with us today, producing continuously identical people for a machine that no longer exists. (Mitra, Sugatra, 2013)

However, the economic reality of today is not identical to that of the 19th century. But modern schools are still products of an expired time, standardised curricula, out-of-date pedagogies, and repetitive standardized assessments for another era. Many schools operate on the assumption that all knowledge is obtained from books, and the relevant information should be stored in the human mind, to be used when necessary. (Mitra, 2013)

The academic and educational consultant British Sir Ken Robinson also defends the need to recognize that the current education system from kindergarden to higher education, was designed on the image of interests of industrialism. Sir Robinson also claims that the concept of the public school as currently we know it, was created for the economic circumstances of the industrial revolution, with the goal of giving minimum competencies to workers of the factories, which up to that time were farmers. (Robinson, Sir, 2006)

Today, schools are still arranged in rows like a factory; with ringing bells to enter and exit, each group in separate rooms, and specializing in independent themes. The students are also educated by lots; organized in a system of age range, as the most important factor of a student is the date of manufacture. (Robinson, Sir, 2006)

Before the 19th century Europe (and in most of the world) education was a privilege reserved mainly to the clergy and to the nobility ruling class. Public education that was paid by public taxes, and free for all - was a revolutionary idea for the time, and

was designed by the intellectual class and culture of the enlightenment for the industrial revolution of the turn of the century. (Robinson, 2006)

Although this education system gave access to open access to public education, Robinson argues that this model also created major social problems. Driven by an economic need, school also created intellectual social divisions, privileging the Illuminist vision of intelligence, in which those with strong deductive reasoning, good knowledge the classics, were considered academically strong. According to the model of public education; there are only two types of people - academic and non-academic; intelligent people and not intelligent people. The result of this mentality is that many students with different learning styles have been judged under this point of view. (Robinson, Sir, 2006)

The original architect of public education (in the USA and England) imagined and created the education as central to cultural life, for the development of the community and the economic growth. Moreover, there was a strategic alliance between the governments and public and private educational institutions, industries, and the political leadership. The rulers of the era recognized that education was the most important investment in their future. (Robinson, K, 2007) At that time, a university diploma guaranteed a profession and a job for life.

2.3 The New Paradigm for the XXI Century

Inevitably, the emergence of computer technology has caused great changes in the level of education, now named as ICT -Information and Communication Technologies, or digital technologies. Kenski explains that many changes have occurred in the ways of teaching and learning since digital technology has become increasingly popular in society. The technology not only extends opportunities for education beyond the short and delimited class time, and the face to face interaction between teachers and students, but they also allow for more interaction between teachers and students, persons, objects and information, and thus redefines the entire dynamic classrooms and creates more class interaction. (quoted in Trevelin et al, 2013)

Robinson claims that when one is interested changing and improving education, one cannot begin with a mentality of production line. The dominant educational policies give importance to the growth of conformity essentially, standardization of notes and results, and the standardisation of curricula. Robinson believes that this is the wrong path; the following path is exactly the opposite. And that is where comes the need for a paradigm change in official education. (Robinson, K, 2007)

When we talk about strategies for the paradigm shift, Robinson believes that it is necessary to work on both the political level of initiatives of schools. Robinson argues that there is a need to change the looming on education in the state and national policy. Therefore, the change involves supporting innovative initiatives in the field, taking into account how the theories of change work in practice, within the schools and in classrooms. (Robinson, K, 2007)

2.3.1. The Information Age

The economic and social reality of the XXI century is very different from the context of the Industrial Revolution of the 19th century. With the development of the centrality of the Internet and digital technologies in human life, a new social paradigm began to emerge, designated as Information Society, the knowledge society or the learning society. (Hargreaves, 2003, Pozo, cited in Coutinho, 2011). However, this new Information Society is not just a passing whim, it implies a profound change, or a new revolution and economic-social organization in the world. (Takahashi, cited in Coutinho, 2011)

This new reality is called as the Post-Industrial era. In 1966, Peter Drucker speaks of the post-industrial society for the first time in his bestseller *The Acts of Discontinuity*, in which economic power has evolved from agriculture to industry and consecutively to services - and focused on a new precious good: information (Crawford, 1983, cited in Coutinho, 2011)

In the nineteenth century, the main source of wealth was labor and manufactured products, while in the 21st century information is most valuable. The Internet plays a key role in providing the vehicle from which information is available to citizens. Unlike products, information is in constant change, and "knowledge is flexible, fluid, always in expansion and shifting" (Hargreaves, 2003, cited in Coutinho).

In this new Post-Industrial Society or the Information Era, the school is no longer the exclusive place for the student to acquire knowledge and to prepare the active life. The possibilities of learning are multiple and are not limited to the physical space of the school, as it was in the Industrial Era. (Coutinho, 201)

2.3.2. The Paradigm Shift in Education

Official schools have the great challenge of creating citizens for this new society. The students need to develop skills to participate and interact in a highly competitive global world, that privilege flexibility, creativity, and the ability to find innovative solutions to the major problems of humanity.

Many companies are now very concerned about the fact that the new generations to be licensed in formal education do not have the skills, skills, or attitudes that they need. The majority of employers are not impressed with a diploma, but in which the person is able to do. (Robinson, K, 2007)

"The dynamics of the information society requires continued education throughout life, which enables the individual not only to accompany the technological changes, but especially to innovate" (Takahashi, 2000, cited in Coutinho, 2011). In this new context, the curricular integration of digital technologies can serve this purpose in official schools, using innovative educational strategies. For such, it is crucial to invest on pedagogical training and continuous technological of teachers. (Coutinho, 2011)

The teacher competencies include not only the basic technological competencies of the use of the computer and the Internet, but should also be able to learn to choose pedagogies and critically choose from available information. As for the student, it is important that this possesses skills required to move from the basic to critical thinking, involving "the dynamic reorganization of knowledge of significant forms and usable" through "three general skills: evaluation, analysis and relating" (Jonassen, 2007, cited in Coutinho, 2011).

Since learning is not static, and it is not confined to the years of schooling, but should be a constant throughout life. (Coutinho, 2011) the new information society has to be, a knowledge society as well. Since the main economic resource of society is the production of knowledge, the capacity of its members to adapt to changes is essential, as well as the ability to learn individually and in collaboration. (Hargreaves Coutinho, 2011)

This same idea of "knowledge society" was a keyword included in the report published by OECD in 2000. The report stresses the responsibility of the school in the development of the values of knowledge, creativity and innovation that make the difference and determine the success in a globalised and highly competitive economy.

Lifelong-learning is not only a luxury, but also" a necessity of which depends on the future of the information and knowledge a society". (Fisher, 2000, cited in Coutinho, 2011). According to Fisher, lifelong learning is more than a chosen path or formative training: it is a mentality, and a habit to acquire. Lifelong learning creates the challenge to understand, exploit and support new essential dimensions of learning, which are in need of new media and innovative technologies to be properly supported. (Fisher, 2000, cited in Coutinho, 2011)

The success of the citizens of the new paradigm depends on its ability to handle and manage the information and, essentially, of their capacity to adapt to change. In addition, this new way of learning includes not only learning to manage information, but also forming social networks and group collaborating. (Jenkins, Henry, cited in Siemens, 2008)**.** To this end, the society of knowledge and learning should be anchored in the four pillars of education: learn to understand, to learn to do, to learn to live together and learn to be. (Delors, 1999, cited in Coutinho, 2011.)

In this context, the role of the teacher also ceases to be a mere transmitter of knowledge, and becomes a mediator of learning. Thanks to the Internet and digital technologies, learning is no longer contained exclusively in school institutions, but is expanded to wherever a student has an internet connection. Nevertheless, this does not mean the extinction of teacher nor does it promote the elimination of the school institution. Schools will always be an institution specializing in production and institutionalization of knowledge. (Coutinho, 2011). What is required is that school institutions open themselves up to the radical changes going on in the new social paradigm, in particular by adopting new pedagogies of collaborative construction of knowledge. (Siemens, cited in Coutinho, 2011).

2.4. Challenges in the Traditional Classroom

The traditional classroom is the form of education we all associate with school. It is so familiar, that it can be difficult to imagine teaching in any other way—many even might question why there is even a need to. (Talbert, 2012)
So what is wrong with the traditional lecture? And why is there a need to change? There are a couple of problems that many teachers and students face: pacing (student differentiation), and lack of time.

The first problem is not with lectures themselves, but with the pacing. (Goodwin, 2013) In other words, the teacher cannot differentiate his teaching to individual needs of the whole class. Some student may have varying levels of understanding of the same information. A small minority of students already were familiar with the topic, feel under challenged and want to move on to something else, while other need further remediation. Without checking students understanding, teachers then assign homework, which many students perform at home with great frustration and confusion. (Goodwin, B. et al, 2013) This system can create passive learners who may struggle through tasks unassisted (Shimamato, 2012). Twenty-year veteran math teacher Karl Fisch, explains "When you do a standard lecture in class, and then students go home to do the problems at home, some of them are lost.
They spend a whole lot of time being frustrated and, even worse, doing it wrong," (Martin , Jonathan, 2010)

The second most common problem is lack of time. Most teachers barely have time to finish teaching a lesson in one hour or less, leaving little or no time is left to do practical activities, a lab, or a discussion. In most cases, the teacher finishes the lesson just about the time the bell rings and students run out the door with the homework assignment. (Talbert, 2012) Moreover, there are other obstacles that many teachers and students face, such as student absences, school closings due to weather, and lack of teacher time to attend to the variety of students' learning types and levels. (Hunley, R, 2016)

This is the classical situation for the traditional lecture based classroom. Many instructors came to the conclusion that the lecture format is not the most effective way of teaching students. For example, math teacher Katie Gimbar, prior to flipping her class, struggled to teach effectively each of her thirty-student classes. She found that she could only teach to the middle or average student of each class. Higher level students were not challenged, and wanted to move forward, while struggling students were not receiving enough effective remediation for their questions. With 90% of class time spent on delivery and review of contents, and only 10% of class time could be spent on actual application- of actually completing hands on problems and exercises. This method was ineffective, because, there was never enough time for differentiation, which is what the students most needed. (Gimbar, Katie, 2011)

Does this so called traditional classroom lecture model of 'broadcast lectures in school, followed by solitary homework in the evening still make sense in the digital age? (Khan, 2012) If only the students had the content knowledge before they came to class.

2.5 Main trends of digital technologies to Education: E-learning, M-Learning and B-learning

One of the most common criticism regarding the current society is its dependence of technology, namely computers, and mobile devices. However, these technologies can become learning tools with high educational potential, in particular in the Flipped Classroom (Sams, 2013). Technology and social software have significantly changed the way students access information and knowledge, as well as how they interact with each other and the teacher, because it expands the possibilities of the classroom in search of information, interaction and collaboration. (Moura, 2010) The innovations of digital technologies that have begun to revolutionize the way we learn have been E-learning, Mobile Learning and Blended Learning (Trevelin et al, 2013) are forms that adopt totally or partically the use of technologies in the room (Trevelin, et al, 2013) To Bergmann and Sams (2012) the educational technologies and the activities of learning are two key components of the flipped classroom. (Moura, 2010)

2.5.1 E-learning or online learning is a learning environment where students are taught in virtual classes, in which they communicate online using information and communication technologies (ICT's) as a platform for teaching and learning activities. (Nichols, M, 2008). Students get assignments sent to them online and they complete and deliver them online within set deadlines.

E-learning has its root in distance learning and is part of the revolution brought by the Internet. Educators and trainers soon found the potential of using digital technology to facilitate student learning. One of the main benefits is it breaks down limitations of time and distance. Moreover, comparative research has proven that there is no difference in the learning outcome of e-learning from traditional face-to-face instruction. (Nichols, 2008)

E-learning theory describes the cognitive science principles of effective multimedia learning using electronic educational technology. Cognitive research and theory suggest that selection of appropriate multimedia modalities may enhance learning. (Mayer, R. E., et al, 1998). Researchers such as Richard E. Mayer, John Sweller, and Roxana Moreno established within the scientific literature a set of multimedia instructional design principles that promote effective learning, motivated by the scientific premise of the Cognitive Load Theory. (Mayer, R, E, 2003 and Clark, R, et. al, 2011)

Increasingly over time, instructors and institutions are incorporating e-learning components in the practice of instruction as a way of facilitating learning, especially in higher education. (Nichols, M, 2008)

2.5.2. M-learning or Mobile Learning lets learners learn and get performance support via their mobile devices. (Chan, J, 2014) A form of distance education, M-learning can also be defined as "learning across multiple contexts, through social and content interactions, using personal electronic devices at their time convenience. (Crompton, H. (2013) and Crescente, M, et. al, 2011)

2.5.3. The difference between E-learning and M-Learning Many agree that mobile devices are a natural evolution of e-learning. What characterizes the transition from E-learning to M-learning is the ease of access. (Moura, 2014)
Many specialists consider that M-learning is actually a new stage of E-learning. Quinn (2000) defines M-learning as the intersection between e-learning and

mobile computing, containing the best of both worlds, accessible resources wherever you are, strong search capabilities, rich interaction, strong support for effective learning, and performance-based evaluation. E-learning is a method that enables learning independent of location, time or space". (cited in Moura, A, 2010)

However, M-Learning, is much more dynamic than just eLearning. Usually phones are accessed on the go, with all the potential distractions. M-Learning needs to be concise and to the point, since people can only spare a short period of time to browse through content. That's why transferring eLearning content to m-Learning simply will not work. (Chan, J, 2014) Some key features of m-Learning include short bite-sized lessons, informal learning space, and just-in-time, and a form of Performance support (Just-in-Time, On-Demand).

Firstly, due to learners' short attention span on mobile and the small screen size of devices, quality m-Learning content is often portioned into a series of short 3-10 minute micro-lessons. Interactive elements such as good typography, images, charts and short tow to three minutes videos are used as these are most memorable and easily absorbed. File size matters to minimize loading time and expensive data charges. (Chan, J, 2014)

Secondly, M-learning brings structured learning into an informal learning space (flexible, self-paced, self-directed). Informal Learning, must happen as naturally as breathing, so it is mostly embedded in other tasks, contextually, often subconsciously, and is always self-initiated. Informal learning is actually proven to be more effective, since actually 70 - 90% of our job-related skills is learned through informal learning. By enabling access to learning outside the classroom, M-Learning creates an informal learning space empowering learners to take charge. Social elements are often included in quality M-Learning platforms often to encourage learners to share their experiences and learn from each other. (Chan, J, 2014)

Thirdly, M-learning must be a form of Performance Support that is *Just-in-time* and *On-demand*. Innovation Expert, Consultant and Author Jim Carroll explains it quite clearly that in the Digital Age, "*The most important skill we will have will be the ability to go out to get the right knowledge for the right purpose at the right time.*" The traditional training/education paradigm is shifting from comprehension and retention to just-in-time learning (JIT learning) to boost performance. M-learning acts as a form of performance support by allowing content to be consumed anytime, anywhere, whenever needed. Performance support materials such as checklist, flashcards and guides are often used as reference for M-Learning. (Chan, J, 2014)

2.5.4. B- Learning, Blended Learning**,** also known as "hybrid learning," "technology-mediated instruction," "web-enhanced instruction," and "mixed-mode instruction" in literature (Martyn, Margie, 2003), is a formal education program in which students learn at least in part through delivery of content and instruction via digital and online media with some element of student control over time, place, path, or pace. (Staker, H., & Horn, M. B., 2012). B-learning falls into the formal learning category, for it differentiates from other informal learning activities students perform on their own. The intention of B-learning is to innovate education by providing "the best of both worlds": the advantages of online learning combined with all the benefits of the traditional classroom. (Martyn, Margie, 2003). Leading blended learning researchers, HeatherStaker and Michael Horn consider B-learning as a hybrid innovation in education, because rather than simply replacing the traditional approach altogether, it merges traditional teaching approaches (face to face teaching contact) with innovative ones (e-learning). (Schell, J, and Mazur, E., 2015)

2.5.4.1 The Four Emerging Blended Learning Models

Dr. Horn and Dr. Staker from the Clayton Christensen Institute defined four main emerging B-learning models: the Enriched-Virtual Model Rotation, the Self-Blend, the Flex, and the Rotation Model. Pedagogically, the Flipped classroom falls in to the Rotation Model of the Blended learning taxonomy. (Schell, J, Mazur, E., 2015)

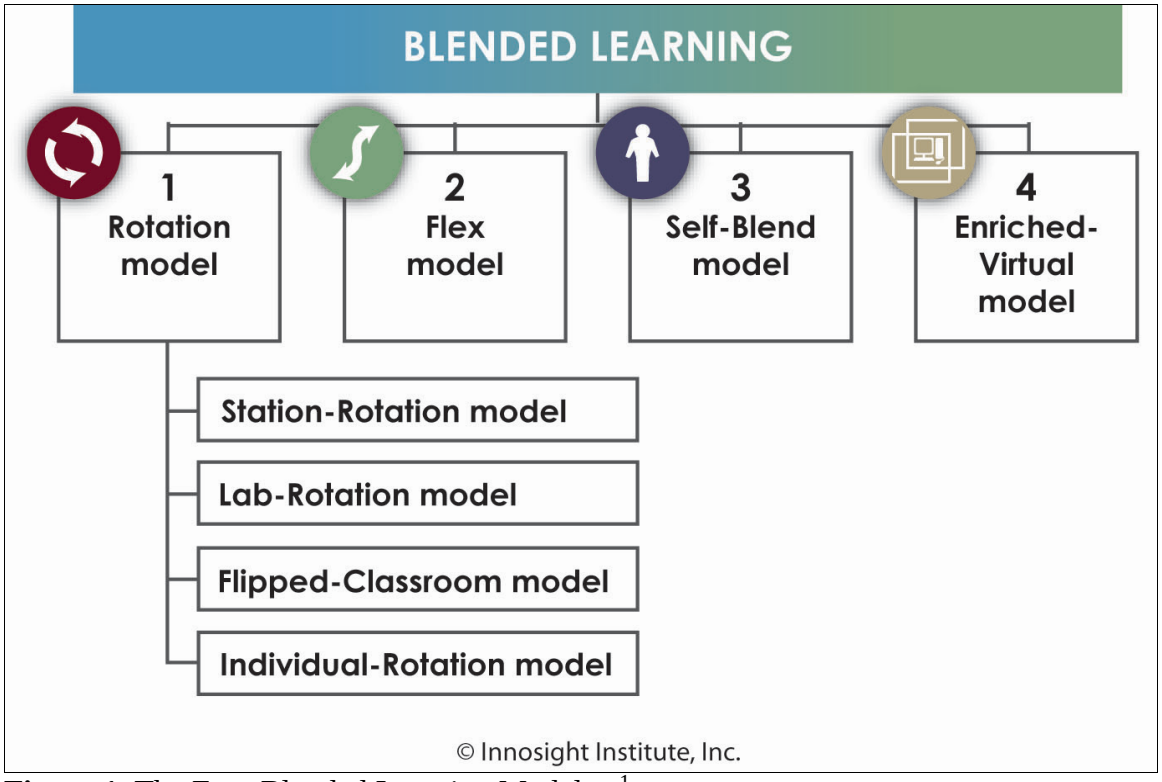

Figure 1. The Four Blended Learning Models, [1]

In the **Flex model,** content and instruction are delivered primarily via the Internet, and students move on an individually customized, fluid schedule among different learning modalities, in the presence of an on-site teacher, who provides support on a flexible and adaptive need basis, which may vary according to a course, program or school. (Staker, H. et al., 2012)

The **Self-Blend model** describes a unique case in which students choose to take one or more courses entirely online to supplement their traditional courses and the teacher-of-record is the online teacher. (Staker, H. et al., 2012)

The Enriched-Virtual model involves a whole-school experience program in which within each course, students divide their time between attending a traditional in class teaching setting on campus, and learning remotely using online delivery of content and instruction. Students seldom attend the on campus class of the weekdays. This model differs from the Self-Blend model because it is a whole-school experience, not a course-by-course model. (Staker, H. et al., 2012)

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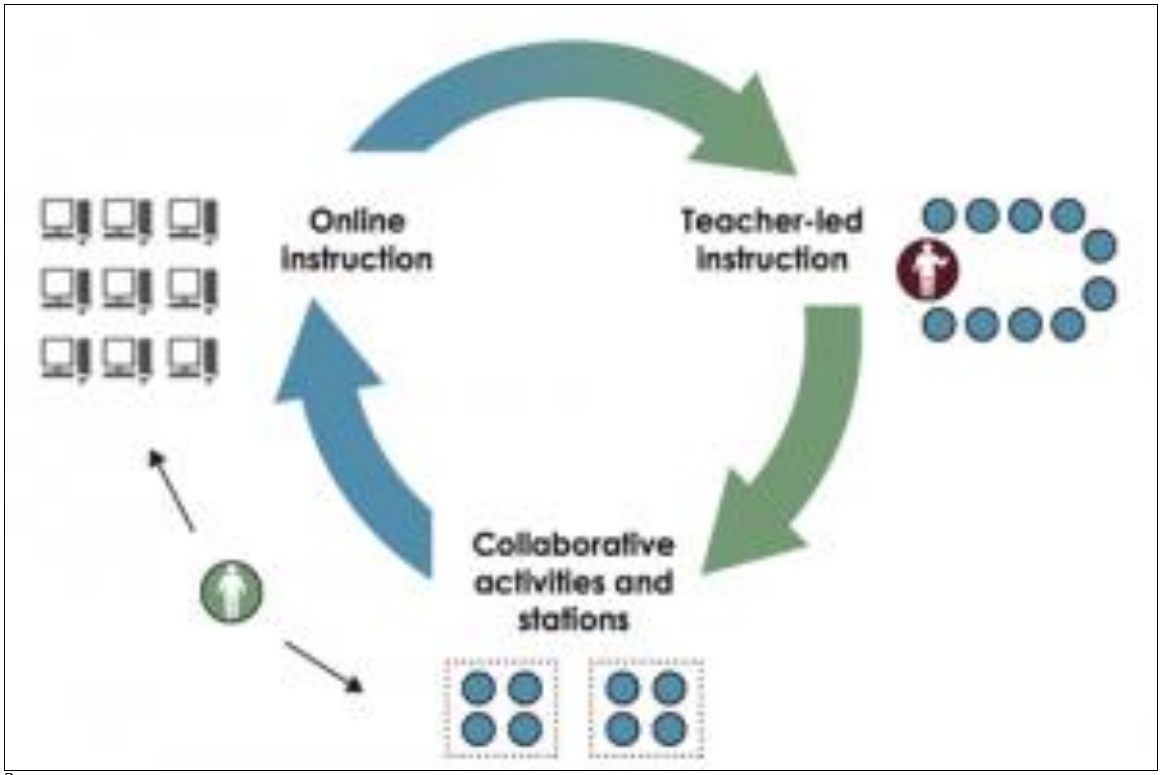
[1] The Four Blended Learning Models, from "Classifying K12 Blended Learning", by Staker, H, Horn, M, 2012, Innosight Institute, retrieved from http://www.christenseninstitute.org/wp-content/uploads/2013/04/Classifying-K-12-blended-learning.pdf, pg 8 <http://www.rcs.k12.in.us/files/page_images/blended%20learning.png>

In the **Rotation model** students rotate between different learning modalities on a fixed schedule between learning online and learning with a teacher in a traditional classroom setup. Online learning may vary between one-to-one, self-paced environment and spending time with a teacher or traditional classroom experience. Other modalities might include small-group or full-class instruction, group projects, individual tutoring, and pencil-and paper assignments. (Horn, 2012) There are three types of Rotation models:

a) In the Station Rotation – some teachers might choose to involve the entire class alternating among activities together, whereas others divide the class into small group or one-by-one rotations. The Station-Rotation model differs from the Individual-Rotation model because students rotate through all of the stations, not only those on their custom schedules.

Example: At the KIPP LA Empower Academy, each kindergarten classroom is equipped with 15 computers. Throughout the day the teacher rotates students among online learning, small-group instruction, and individual assignments. (Staker, H. et al, 2012)



[2]**Figure 2.** Station-Rotation Model figure: KIPP Empower,

b. In the **Lab Rotation** model, students rotate among different school locations, instead of staying in one classroom for the blended course or subject of the station-rotation. (Staker, H. et al., 2012)

[2] Station-Rotation Model figure: KIPP Empower, from "Classifying K12 Blended Learning", by Staker, H, Horn, M, 2012, Innosight Institute, pg 9, retrieved from

Example: Students at Rocketship Education rotate out of their classrooms to a learning lab for two hours each day to further their instruction in math and reading through online learning. (Staker, H. et l., 2012)[3]

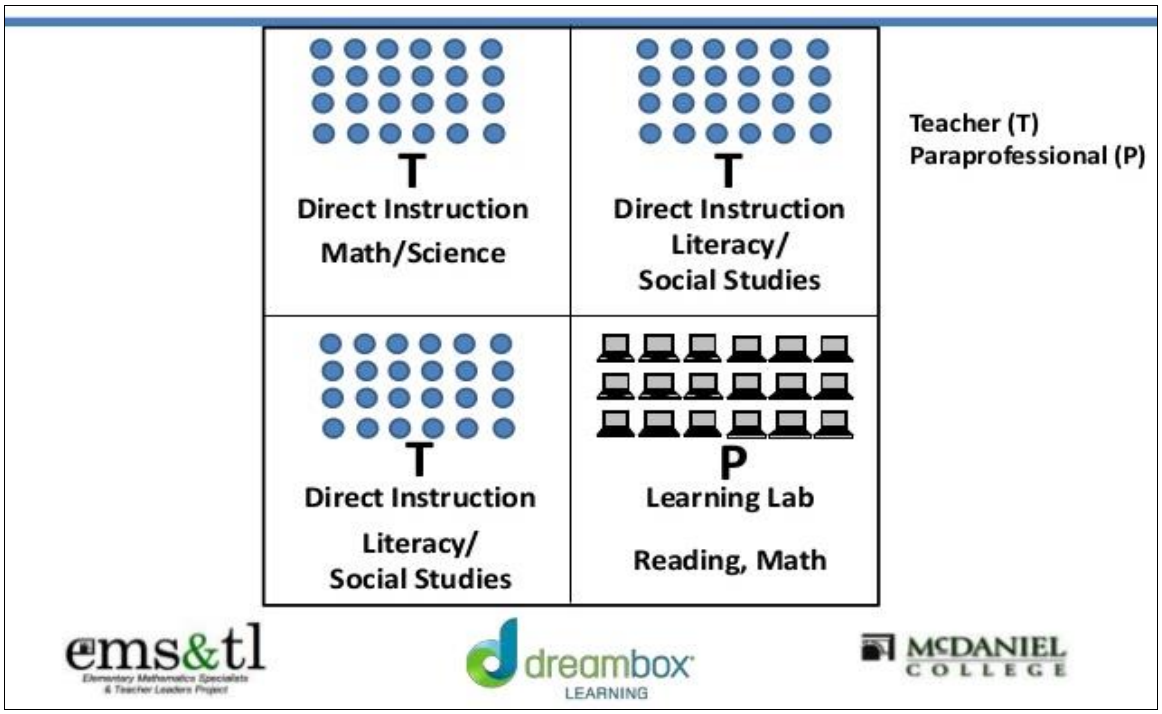


Figure 3. Lab Station Rotation Model figure

[3] from "Classifying K12 Blended Learning", by Staker, H, Horn, M, 2012, Innosight Institute, pg. 10, retrieved from <http://image.slidesharecdn.com/02-27-13edwebwebinarjeffpiontektimhudson-130821153220-phpapp02/95/principals-guide-to-blended-learning-for-elementary-mathematics-19-638.jpg?cb=1377099218>

c. In the **Individual Rotation**, students rotate on an individually customized, fixed schedule among learning modalities, at least one of which is online learning. In this model, a teacher or assistant sets individual student schedules. The differing factor of this model is that students do not necessarily rotate to each available station or modality. (Staker, H. et al., 2012)

Example: Carpe Diem Collegiate High School and Middle School assigns each student a specific schedule that rotates them between online learning in the learning center and offline learning. Each rotation lasts 35 minutes. (Staker, H. et al., 2012)

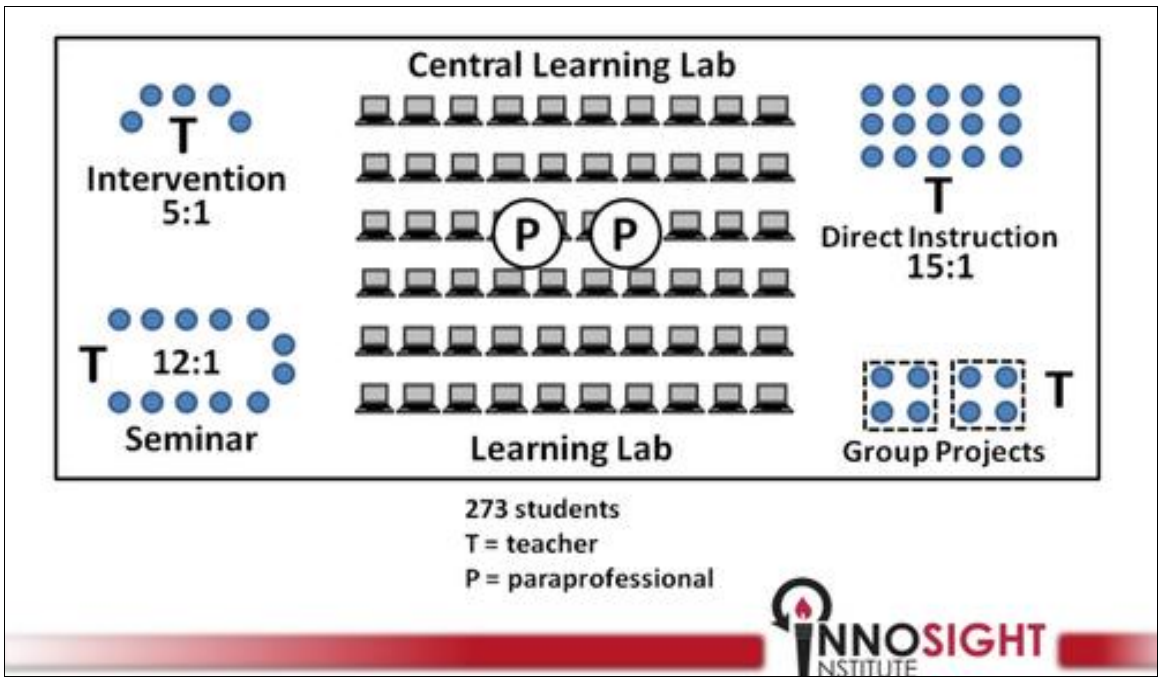


Figure 4. Individual-rotation Model: Carpe Diem School,[4]

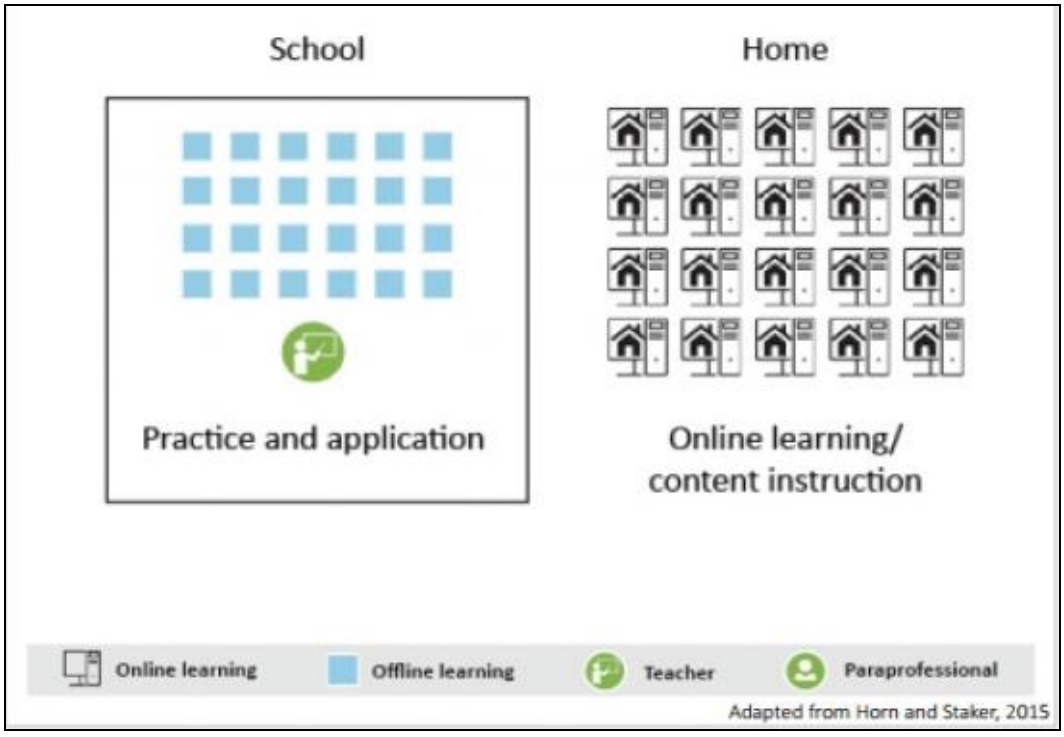
[4] from "Classifying K12 Blended Learning", by Staker, H, Horn, M, 2012, Innosight Institute, pg. 12

<http://www.mathmirror.org/images/blog/digital-learning-2.png>

d. In the **Flipped Classroom model,** students rotate on a fixed schedule between face-to-face teacher-guided practice on campus during the standard school day and online delivery of content and instruction from a remote location after school, usually at home. It is important to note that in the Flipped Classroom, students receive the primary delivery of content and instruction online before class. According to the B-learning theories of student control over time, place, path, or pace, students can choose the location where they receive content and instruction online and to control the pace at which they move through the online elements. (Staker, H. et al., 2012)

Example: At Stillwater Area Public Schools in Minnesota, students in grades 4–6 math classes watch videos or access an online explanation after school at the location of their choice to watch 10-15-minute asynchronous instruction videos and answer comprehension questions on Moodle. At school they practice and apply their learning with a face-to-face teacher. (Staker, H. et al. 2012)

[5]**Figure 4**. The Flipped Classroom Model



The focus of this study is concerned with an in-depth exploration of the Flipped Classroom, the third Rotation model of Blended Learning, which has received the most attention in the press.

[5] from "Classifying K12 Blended Learning", by Staker, H, Horn, M, 2012, Innosight Institute, pg. 11, retrieved from <http://www.readinghorizons.com/Media/Default/Images/blended-learning/rotation/rotation-3.jpg>

3. Flipped Classroom Literature Review

Introduction

If the school wants to remain current, differentiate instruction, support best practices, and increase student achievement, blended learning in the form of a flipped model may be a good option. (Keene, 2013) The Flipped Classroom has emerged as both a disruption and an opportunity for the education community. The concept inverts or flips traditional thinking about the process of instruction, and utilises innovative strategies involving digital technology to deliver materials and resources. (Estes, M.D. et al, 2014).

In recent years, there has been a considerable amount of attention in the academic press regarding the Flipped Classroom – mainly in academic newspaper articles and online blogs. It even made it to mainstream media, namely the daily news (CBS,etc). Complete websites dedicated to promoting the flipped classroom ideology have also been popping up. The online buzz is not only limited to promotional websites and informational articles, but organizations are also beginning to market materials to help instructors who want to implement the flipped model in their classroom, providing resources for making screencasts and instructional videos. In addition, many websites even offering certifications for "Certified" flipped classroom instructors (Bishop, 2013) So what is the Flipped Classroom exactly? What are its origins and definition? Why did it come about and what part does it play in the new education paradigm?

3.1. Origin and Chronology

The origin of the concept of the Flipped Classroom is not new to the XXI Century. Simply defined as changing the learning environment to a student-centered environment, the Flipped Classroom model has been attempted frequently in the past and been in existence prior to the advent of digital technology. The earliest example is of ancient Greek philosopher Socrates, who emphasized the necessity of active dialogue in his teachings. In the XIX century, Christopher Columbus Langdell, applied the Socratic Dialogue to probe student understanding in class for his law students, who must prepare before they come to class by reading cases and then answer questions. (Schell, J, and Mazur, E. 2015)

In the early 19th century, US military General Sylvanus Thayer of West Point created the Thayer Method, a system for his engineering students in which he provided a set of materials for his students, who were responsible for learning the core material before coming to class. The objective was to focus class time for critical thinking and group problem solving. (Musallam, R., 2001)

With the invention of the television and radio in the early 1920's, the possibility that they could be used to deliver education content began to surface (Byrne, 1989 cited in Overmyer). In 1922, Thomas Edison, known for developing sound recording and the motion picture technologies, recognized the value of this invention in education. He believed "the motion pictures, is destined to revolutionize our education system, and will supplement our textbooks with 100% efficiency. (Roques, S, 2014)

It was not until the early 1960s that this idea gained fruition in the UK when social reformer and political activist Michael Young founded the Open University, which became the most successful, full-scale project to use video to deliver educational content. (The OU Story, Viewed 11/04/2016)

Intended to create more social inclusion in higher education for lower income groups, the project was also called the "University of the Air", a daily distance education television program viewed early mornings throughout the United Kingdom, Canada, and Australia. This project has progressed along with technology to meet the needs of their students and today students taking courses on mobile technology, connected to a network of tutors who provide support to students via email or computer conferencing. Tutors also meet face-to-face with students to create active learning experiences beyond lecture, in a blended learning environment resembling the flipped classroom. (Overmyer, 2014)

In 1956 Benjamin S. Bloom, the Associate Director of the Board of Examinations of the University of Chicago, and his team published the Taxonomy of Educational Objectives, Handbook 1: The Cognitive Domain (Bloom et al. 1956), a crucial book for education and reference for flipped teaching. (Bumen, Nilay, 2007) With the intention of simplifying the preparation of annual examinations, Bloom and his team created a framework for classifying statements of what teachers expected students to learn as a result of instruction. The framework was intended to provide for classification of educational system goals, especially to help teachers, administrators, professional specialists, and research workers to discuss curricular and evaluation problems with greater precision. (Krathwohl 2002) Bloom's Taxonomy included six major categories in the cognitive domain: knowledge, comprehension, application, analysis, synthesis and evaluation. It was assumed that mastery of each simpler category was prerequisite to mastery of the next more complex one (Krathwohl 2002 cited in Bumen, Nilay, 2007)

In fact in 1968, Benjamin S. Bloom first developed the innovative instructional strategy and educational philosophy called Mastery Learning, commonly used by many flipped instructors today. Originally called, "Learning for Mastery", this instructional strategy privileged the time required for different students to learn the same material and achieve the same level of mastery. At a time when the traditional education model was standard, this strategy was innovative for its time because it provided students with the much needed differentiation, (Levine, Daniel U., 1985) As Bloom intended, this method was successful in improving grades, lessening the divide between students in class.

However it was not to the 1990's that the modern term Flipped came about, as many voices began emerging the idea. In 1993, Alison King published "From Sage on the Stage to Guide on the Side", an article that states the importance of the use of class time for the construction of meaning rather than information transmission.

In 1995, Dr. Baker presented the concept of as "The Classroom Flip" to conferences between 1996 and 1998. He had tried applying one of the first online content management systems, by placing his lecture notes online, for further classroom discussions and use online quizzes, opening up class time for students to work on applications of the content and answer questions. (Strayer, 2007, Baker, 2011, cited in Overmyer, 2014)

In 1997, Harvard physics professor Eric Mazur began flipping his classroom, proposing a Peer-based Learning, a pedagogy, based on question-making in class, instead

of focusing on the lecture. His students prepared to learn before class by reading and answering questions about the material (Goss, Tricia, 2014)

In 2000, Lage, Platt, and Treglia referred to the concept as "The Inverted Classroom" and similarly held the expectation that students would view lectures in advance of class, and then spend class time clarifying difficult concepts and working in small groups (Lage, Platt, & Treglia, 2000). They provided students with a variety of tools to gain first exposure to material outside of class, including textbook readings, lecture videos, and printable instructional slides (Johnson & Renner, 2012) (Overmyer, 2014) However, the paper, published in 2000 by the University of Miami-Ohio, "didn't take off," said Bergman. "It wasn't the right time." YouTube was yet to flourish. The infrastructure of video sharing was not in place. (Goss, Tricia, 2014)

One of the most recognizable contributers to the Flipped Classroom movement is a former hedge fund analyst, Salmon Khan. (Thompson, Clive, 2011). In 2004, Salman Khan, experimented tutoring his cousin in mathematics over the internet, at the request of his cousin, so she could skip over the parts she understood and spend more time on the parts she had trouble with. In 2006, Salmon Khan founded The Khan Academy, a non-profit educational organization with the slogan a "free, world-class education for anyone, anywhere". (Noer, M., 2012) To their surprise, they found that this worked very well. Khan began publishing his lectures on YouTube and the concept took off. (Thompson, Clive, 2011),

Khan Academy has become synonymous with the flipped classroom to many, however, these videos are only one form of the flipped classroom strategy (Sams, Aaron , 2011). But in reality, online lectures are a key tool to many Flippers. (Goss, Tricia, 2014)

In spring of 2007 physics high school teachers Eric Bergmann and Aaron Sams of Woodland Park High School in rural Colorado, decided to record all their lectures in small vodcasts, using a software that could record a PowerPoint slide show with voice and notes they found in a technology magazine. The following year, they decided to use the technique for all their classes (Goss, Tricia, 2014). The early recordings were only for students who missed class and were coined "pre-broadcasting (Bergmann & Sams, 2012) "Our absent students loved the recorded lectures. Students who missed class were able to learn what they missed. Some students who were in class and heard the live lecture began to re-watch the videos. Some would watch them when reviewing for exams. And we loved it because we didn't have to spend hours after school, at lunch, or during our planning time getting kids caught up." (Bergman &Sams, 2012).

The term Flipped Classroom is often credited to Bergman and Sams, who found a creative solution to the fact that many students had to be absent, or needed to leave early in the day to attend athletic events or other school related activities. (Overmyer, 2014)

Since their videos were posted publically online, they received emails from students and teachers all over the world. Soon, they were solicited around Colorado to offer professional development workshops on what they were coined the "pre-vodcasting", or "Educational Vodcasting" method. (Sams, Aaron, 2011)

At the time, they found that no other references to this method on the internet. The name was briefly changed to reverse instruction, but in 2010, Dan Pink referred to this method as the flipped classroom and the name stuck (Bergmann & Sams, 2012). Since 2009, Woodland Park High School has organized a summer workshop introducing the

flipped learning model to new educators. Since then, attendance has grown every year. For example in June 2012, the conference held over 500 attendees (Overmyer, 2014)

It was Salman Khan who used the term “flipping the classroom” for the first time in his TED talk, held in March of 2011 in (Khan, 2011). Since then, interest in the flipped model has grown exponentially with new articles, press, and blogs on the flipped model appearing almost daily. Soon after, Bergmann and Sams were being asked to do their workshops all over the United States and then around world. (Overmyer, 2014)

The Clayton Christensen Institute, an education reform organization and think tank formerly Innosight Institute, has published several articles described the Flipped Classroom, contextualizing it as one of the Blended learning Models, a formal education programs that combine online learning and brick-and-mortar schools. (Christensen, et. al 2013, and Clayton Christensen Institute, "Our History," accessed April 2, 2014)

3.2. Definition of the Flipped Classroom

The Flipped Classroom is an instructional strategy and a form of blended learning, where students watch video lectures outside of class to learn content (usually online), and then do their homework in class with the presence and guidance of teachers. Students can now learn at their own pace and save class-time for interaction. (Saomya, Saxena, 2013) This approach requires students to engage themselves outside of the classroom as well as in it. (Skonnard, Aaron, 2015)

The flipping, inversion, or reversal that is at the heart of what is known most commonly known as the Flipped classroom. Simply put, in the Flipped Classroom, the lecture and homework switch places. The core idea of the Flipped Classroom is to invert the common teaching approach: instead of using class time to lecture, students learn in advance of class via video or interactive lessons or any other mode of content exposure (reading, DVD), and/or class becomes the place to apply the material, through problems, advance concepts, and engage in collaborative learning. In this way, all aspects of instruction are rethought to maximize the scarcest learning resource—time. (Tucker, 2012)

The use of the technology enables students to view lectures either in computer labs or at home, whereas homework assignments can be done in class, in groups" (Glenn Platt, and Michael Treglia 2000). Although technology is suggested, it is not a requirement. Students can view the lesson online, DVD, or read a section of the book or online as the pre-class assignment, followed by a short quiz.

High school chemistry teachers, Bergmann and Sams (2012) have a more holistic approach, defining flipping as a mind-set that directs attention away from teachers and puts it squarely on the students and their learning. (Schell, Julie, 2015)

Harvard Physics professor Eric Mazur, describes his Inverted Classroom as moving information coverage out of the classroom by requiring students to read before class: "the key point is to get students to do part of the work ahead of the lecture" … requiring his students to read the text book and lecture notes before coming to class (Schell, Julie. 2015)

The most efficient way of describing the Flipped classroom is by comparing it to a traditional class, which Julie Schell does this in a sixty second video. In a traditional class teachers exposes new material to students through a lecture. In a flipped class, students learn the material outside the class, via video or reading before the class meets by watching a lecture video created by their teacher or other, or by completing a reading assignment. Students prepare for class by doing some kind of quiz activity. Then, class time is used for students to apply the concepts or ideas they covered previously outside of class, interacting with peers and their instructors whenever needed. After class students use feedback gained during class time to further their learning by reviewing concepts they still needed to work, thus completing the cycle. The teacher still has an important role as a guide through the learning process, keeping the learning goals in mind throughout the entire process are, making clear what students should know and be able to do with the particular content being studied. (Schell, Julie, Apr 22, 2013**),**

3.2.1. The Expanded Definition

Despite the increasing popularity of the Flipped Classroom in educational research, it is there is still ambiguity in its definition. Since it is still relatively new, there are varying ideas and opinions. Most definitions imply that the Flipped Classroom involve a mere inversion of classroom and at-home activities.

There are other definitions that describe the flipped classroom as a student-centered learning environment, preferably using collaborative strategies, although, it is possible to flip a class using individual activities such as quizzes, worksheets, reflective writing prompts, and problem solving assignments. (Honeycutt, B., & Garrett, J., 2014)
The key shift is in the use of class time to complete these activities rather than lecturing. Essentially, all aspects of instruction can be rethought to best maximize the scarcest learning resource- time. (Tucker, 2012)
Dr. Jacob Bishop defines the flipped classroom as an educational technique that consists of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom. According to Bishop, more than a mere re-arrangement of activities, the Flipped Classroom actually represents an expansion of the curriculum. Most research on the flipped classroom employs group-based interactive learning activities inside the classroom, citing student-centered, active learning theories (Bishop, 2013)

In the last decade, there have been several academic terms have come up in research literature referring to the same concept, such as inverted classroom (Lage & Platt, 2000), Just-In-Time teaching (Novak, 2011), Flipped Classroom (Bergmann & Sams, 2012), Inverted Learning (Davis, 2013), Reverse Instruction, and Hybrid Learning. All terms are presented in the literature to describe a method that emphasizes student preparation before class. These different names indicate that this is not a static definition, but an evolving method or approach. (Hung, 2015)

The only fixed element in the flipped classroom is precisely inverting the order of homework and classwork. (Bennet, et.al, 2013) From this basic premise of the Flipped Classroom, switching the order of the "lecture" and "homework" components of the class, springs many unique and interesting forms. According to Mark Frydenberg from the Huffington Post, “It is not a ‘one size fits all’ model.” He points out that every classroom is different, with different levels of access to technology, different levels of motivation on the part of the students, and different technological know-how on the part of the instructors. (7 Unique Flipped Classroom Models, 2014.)

The format the teacher choses to introduce the material to the students can vary between textbook, DVD, powerpoint presentation, LMS, videos from other teachers or custom made videos. Regardless of the form that the flipped classroom takes on, the goal is to bring a blended learning model of instruction to the students that allows for differentiated instruction for students. (Keene, 2013) According to the Flipped Learning Community, flipping is about pedagogy not about technology. (Schell, J. and Mazur, E. (2015)

3.3. Different Terminologies for the Flipped Classroom

As the term flipping becomes more commonly used, it is important to clarify and define terminologies. Research mentions various names attributed to the Flipped Classroom, such as the Inverted classroom (Treglia et Lage, 2000, Mazur), Flipped Learning (Bergman, Sam), "Flip Teaching" and "Reverse teaching" or a "Backwards classroom", and "Reverse instruction. (Fisch, 2010)

Afterall, what is the difference between all these terminologies? The term Flipped Classroom, (also found as Inverted classroom, flip teaching or reverse teaching, or backwards classroom), refers simply to inverting the order of lectures and homework, having students read text or watch videos prior to class, and use class time to solve problems or engage in hands-on projects..

However, Flipped Learning leaders (the Flipped Learning Network (2014) and Talbert) distinguish between a Flipped Classroom and Flipped Learning. (Estes, et. Al, 2013)

Flipped Learning is a pedagogical approach that shifts direct instruction from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter (Flipped Learning Network, 2014).

In addition, to engage in Flipped Learning, teachers must incorporate the following four pillars into their practice (Flipped Learning Network, 2014):

The first pillar involves *Flexible Environments*- where the learning environment is physically rearranged to accommodate different types of learning and where there is flexibility in timelines for learning and assessment;

The second requirement is the existence of a *Learning culture* with a learner-centered approach that features student construction of personally-relevant knowledge is used;

The third pillar involves *Intentional Content*, designed to promote critical and higher-order thinking, according to the levels of Bloom's taxonomy of the cognitive domain, in student-centered activities in and outside the classroom;

The last pillar refers to the *Professional Educator*, who works as an active observer who offers timely and relevant feedback and assessment, connectedness, reflection, revision; who allows a "controlled chaos" during class time. (Network, F. L. ,2014)

It is also important to distinguish other active learning strategies from Flipped learning. Prior to the Flipped Learning Network (2014) publication, it was easier to confuse Flipped Learning with a wide range of learner-centered approaches. Previous research into best practices in teaching and learning, showed that "any learner-centered educator would provide activities in the classroom that are action based, authentic, connected, and collaborative, innovative, high-level, engaging, experience-based, project-based, inquiry-based, and self-actualizing" such as peer instruction, active learning, priming, and pre- and post-class modelling, designed to reduce cognitive load, as important aspects of flipped learning. (Hamdan, McKnight, McKnight, & Arfstrom, 2013, cited in Estes, 2014).

3.4. The Traditional Classroom vs the Flipped Classroom

In a nutshell, the traditional classroom structure revolves around the teacher lecture, which students attend by listening passively while taking notes, and are given assignments based on the material presented during the classroom. Most commonly the instructor talks about concepts from the textbook, which apparently constitute "everything" the students need to know. This is followed by exercises, usually assigned for homework, which students must complete alone.

In this structure, students are essentially procedurally bound, going through the motions without reflecting on their meaning. Consequently, the grades assigned do not take into consideration the students' skills and depth of observations. Harvard Professor Eric Mazur gives the analogy, describing students as cooks, who learn and follow instructions from recipes (Mazur, 2015)

Most specialists agree that there is more to flipping than just watching videos of lectures and doing exercises in class. A video of a lecture is still a lecture. One of the main reasons for flipping the classroom is to shift from giving preference to lecturing as the primary means of delivering content and organizing class time. The teacher can develop an excellent lecture effectively, but the instructors often rely exclusively on the lecture, and often forget or don't have time for other alternative more meaningful teaching and learning strategies. (Honeycutt, B., & Garrett, J., 2014).

Professor Mazur believes the main reason the traditional method of teacher is still being used is mainly due to habit – people tend to teach the way they were taught. The idea is simply that getting information by receiving content out of class, whether it may be reading a book, or use an LMS, or by watching a video, depending on the teacher and student preferences. Mazur claims that listening is not as efficient as self-paced reading. While listening is a largely passive activity, reading more easily engages the mind and it allows more time for the imagination to explore questions. (Mazur, 1997) Other specialists provide a variety of sources where students can be exposed to content, either reading a text (digitally or paper), watch video lectures, presentations, DVD's.

But the idea is not to stop teaching altogether, nor that students watch videos or read books instead of going to lectures. The key point is that the first exposure to new material comes before the lecture period. Lectures can be used to give students a sense of what is most important in the material they have learned, that relate to previously studied material, to check conceptual understanding, to paint a broader picture, to relate theories to observations, to provide a different perspective, or even to lecture on points not covered in the reading. (Mazur, 1997)

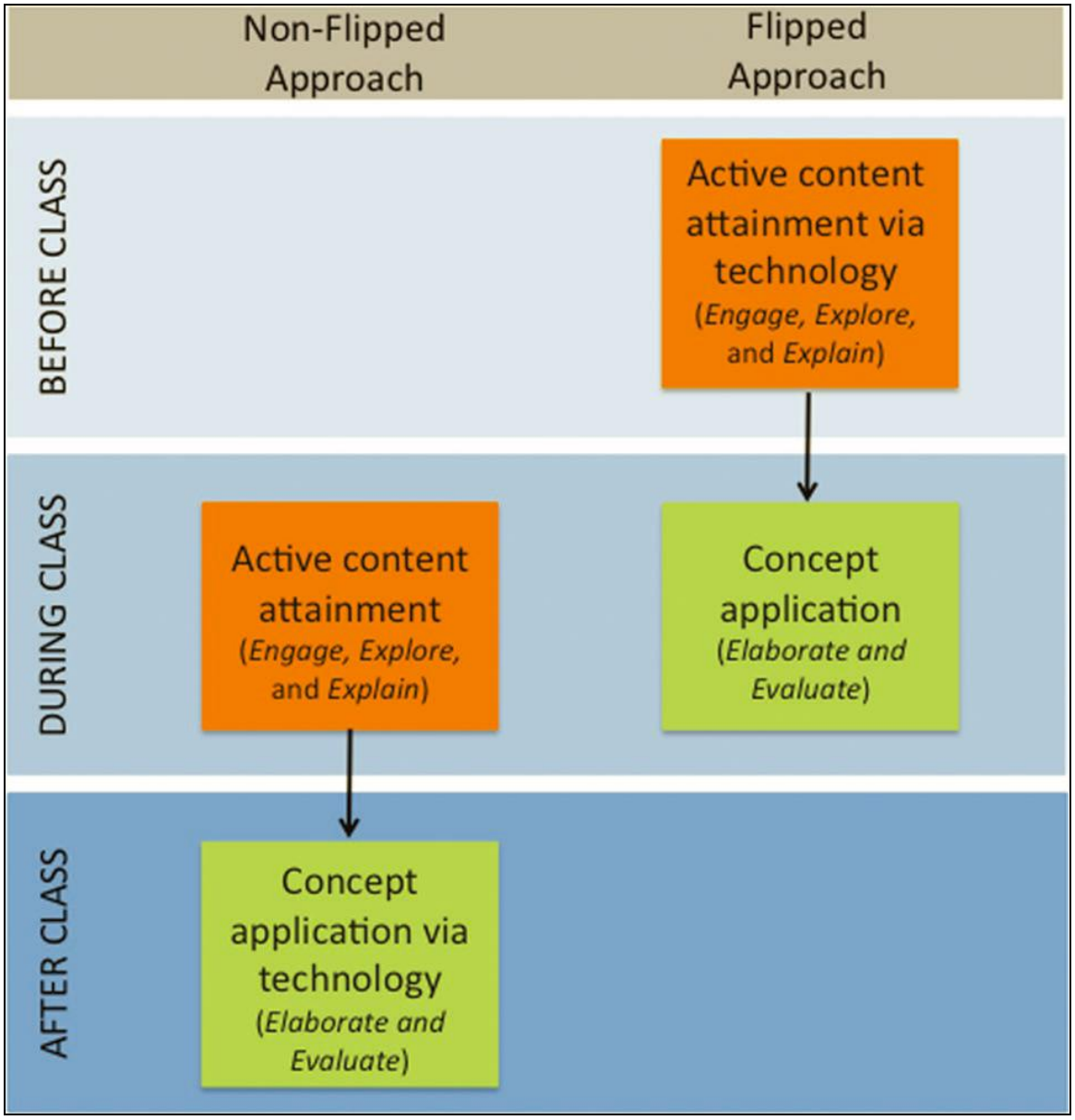


Figure. Flipped Approach vs the Traditonal Classroom Approach. (Jensen, J, et al, 2014)

3.5. Implications for Teaching and Learning

The flipped classroom model implies a role change for both instructors and students. In essence, the active role of the teacher as the "sage of the stage", now assumes the role of a guide on the side for a more collaborative and cooperative contribution to the teaching process. (Bergman, J, Sams, A., 2012) Students now assume the active role in the classroom, instead of merely passive participants in the education process. The flipped model puts more of the responsibility for learning on the students, in which activities are student-led, and student communication become the determining dynamic in class, through hands-on work. In terms of learning, there is a distinct shift in priorities from just covering material to actually mastering it. (7 Things you should know about flipped classrooms, February, 2012)

By flipping the classroom, an instructor intentionally designs a flexible experience to engage students in asynchronous online learning followed by synchronous active learning during a scheduled class time. (Estes, M.D. et al, 2013) Thus, within this new lens, and student-centered perspective, and more efficient use of class time, teachers are now free to create their own Flipped Classroom version.

3.5.1. The new role of the teacher

One of the best steps the teacher must take to flipping the classroom is to for instructors to begin is by re-thinking their role in the classroom. The teacher in the flipped classroom has a very different role than that of the traditional classroom. Since learning is now student-driven, the teacher is no longer the sole source of knowledge. The instructor assumes the role of a guide, assisting the students to find the sources of knowledge themselves. (Goss, T, 2014)

The instructor is no longer a 'lecturer' but assumes the role of a guide for students learning. The main goal is to provide an understanding of effective practices and basic procedures and tools used to analyze, design, develop, implement, and evaluate a *flipped learning* experience. (Estes, M.D. et al, 2014). When the energy in the classroom shifts to the student, that might mean relinquish a degree of control, learning to accept a 'controlled chaos'. (Honeycutt, B., & Garrett, J., 2014)

Jonathan Martin believes that "Increasingly, education's value-add is and will be in the coaching and troubleshooting when students are applying their learning, and in challenging students to apply their thinking to hands-on learning by doing and teaming: so let's have them do these things in class, not sit and listen". (Martin, Jonathan,)

A successful 'flipped teacher' also assumes the role of designer of the course. Managing the digital content of the subject material in a syllabus involves knowledge of instructional design as well. The nature of flipping a classroom is similar to that of classroom-oriented instructional design models where the instructor of a course serves in many roles that may include subject matter expert, instructional designer, and media developer. (Estes, M.D. et al, 2014

One of promises of flipping is actually based on instructional design strategies. For example, inverting the content and homework order enables a more effective use of class time, where active learning strategies can applied, which are proven to help increase student learning outcomes. (Estes, M.D et al, 2014)

Teachers who chose to flip must make important decisions regarding content sequencing and flexible formatting for access and delivery both in and outside of scheduled class time. (Estes, M.D et al, 2014)

3.6. Learning Theories associated to the Flipped Classroom

The success of the flipped classroom is associated to three important findings on the science of learning. According to John Bransford's principle A 'metacognitive' approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them". From his book *How People Learn*, he claims that in order for students to develop competency in a given area of study, they must:
1) have a deep foundation of factual knowledge;
2) understand facts and ideas in the context of a conceptual framework, and organize knowledge in ways that facilitate retrieval and application". (Bransford, J, 2000)

The idea is that the flipped classroom provides an opportunity for students to *use* their new factual knowledge while they have access to immediate feedback from peers and the instructor, helping students learn to correct misconceptions and organize their new knowledge The immediate feedback that occurs in the flipped classroom is crucial to helping students recognize and think about their own learning. Although students' thinking is not an inherent part of the flipped classroom, the higher cognitive functions put into practice through class activities, along with the ongoing peer/instructor interaction , can readily lead to the metacognition associated with deep learning. Brame, C., 2013)
In addition to Behaviorism, Cognitivism, Constructivism, and Socio-constructivist, Bloom's Taxonomy, and in particular Bloom's Revised Taxonomy is one of the most important learning theories associated to the flipped classroom:

3.6.1. Bloom's Taxonomy in the Flipped Classroom

Bloom's Taxonomy provides the framework for comparing the lecture-centered class to the flipped class. In the Flipped Classroom, instructors use face to face time to focus on higher level learning outcomes and lower level outcomes outside of class. This means the flip could be as simple as watching a video before class for the lower level cognitive stages (Knowledge, Comprehension), and then attending class for more in-depth discussions that involve the higher level skills of judging, analyzing, and creating. If students work with the fundamental material before class, they are better prepared to apply the information and engage in higher-level discussions with their peers and the instructor. (Honeycutt, B., & Garrett, J., 2014).

Bloom's Taxonomy (1956), is a framework applied by generations of K-12 teachers and college instructors in their teaching, consists of six major categories: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation.

The *knowledge* level refers to the ability to remember facts, concepts, or principles while the second level, *comprehension,* requires students to understand what they know and to "translate" the known into their own words, and demonstrating their understanding of a given concept. The third level, *application,* assumes that the learner knows and understands something before using this knowledge and understanding in a unique event without being prompted to do so. The top three levels of the taxonomy require that

learners know, understand, and use what they know before thinking in the higher domain. Cocklin, Jack, 2001

The Revised Taxonomy (2001) points to a more dynamic conception of classification, versus a static notion of "educational objectives" (in Bloom's original title). Instead of nouns, the authors of the revised taxonomy underscore use verbs and gerunds to label their learning categories. These "action words" describe the cognitive processes by which thinkers encounter and work with knowledge. Thus, the new list now includes Remember; Understand; Apply; Analyze; Evaluate; Create. (Cocklin, J., 2001)

Thus, using a more updated Bloom's Revisited Taxonomy, students are doing the lower levels of work- gaining knowledge and understanding, outside of class, and focusing on the higher forms of cognitive work- analysing, evaluating and creating in class, with the support of their teacher and peers. Brame, C., 2013)

3.6.2. SAMR in a nutshell, is a four-part continuum (Substitution, Augmentation, Modification and Redefinition), where technology is implemented to improves rigor and depth of learning in order to maximize educational results. (Leimbach, Lydia, 2015) Samr can be considered an alternative or parallel Learning Taxonomy to Bloom's Taxonomy. SAMR is a tool for technology integration, developed in 2010 by Dr. Reuben Puentadura and has been used worldwide to move the use of technology in the classroom from simply replacing the teaching tools to transforming the kinds of tasks that students can actually do. This taxonomy is relevant to the Flipped Classroom, because, when technology is added to proficiency-based learning, this is considered blended learning. . (Leimbach, Lydia, 2015)

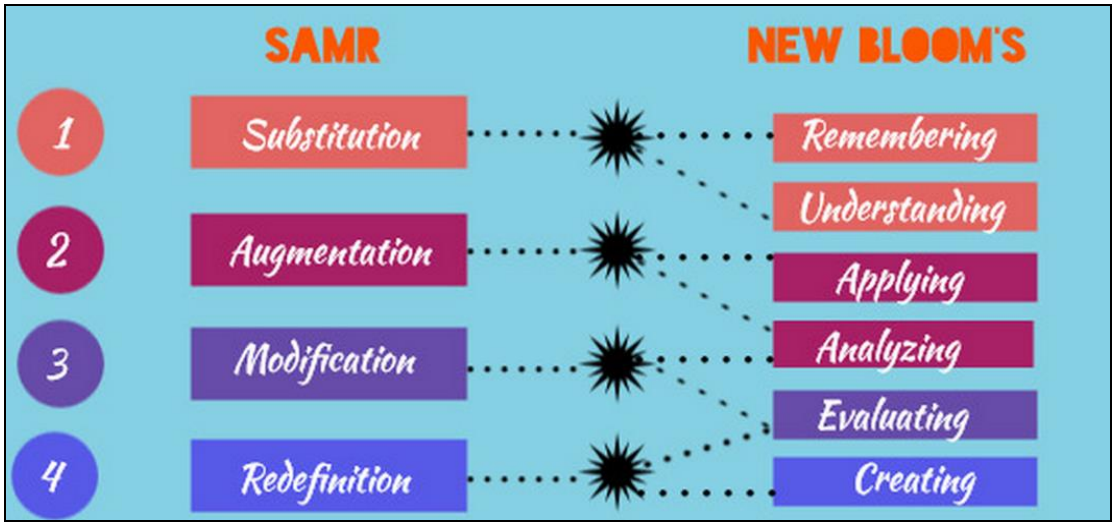


Figure SAMR vs Revised Bloom's Taxonomy, Retrieved from: https://www.thinglink.com/scene/531154089749250048

The **Substitution** stage is where you use technology to substitute traditional education tools, such as pen and paper, or a blackboard. A simple example is using word processor to type a story instead of handwriting it. (A New Excellent Interactive SAMR Visual, 2012). Thus, digital technology acts as a direct tool substitute, with no functional change. (Puentedura, R, 2009). The actual learning works the same way with or without the use of the technology. (Leimbach, L, 2015)

In the **Augmentation** stage, technology acts as a direct tool substitute, with functional improvement (Puentedura, R, 2009), offering extra value to the learning and does not transform how it is done. Instructors can easily providing resources in a variety of media formats to suit the learner needs, allowing them to choose what works best for them. (Leimbach, L, 2015) For example of this is the use of a spell checker, grammar checker or electronic dictionary, which introduces small noticeable improvement. A New Excellent Interactive SAMR Visual, September 12, 2014
Another example is the use of flipped videos, which can also provide review opportunities for those students who need to hear or see something more than once. These may be brief lectures, demonstrations, or presentations. Leimbach, Lydia, 2015

In the **Modification stage, t**echnology allows for significant task redesign (Puentedura, R, 2009) This is the level where technology is being used more effectively not to use different tools to do the same task, but to actually redesign new parts of the task and transform students learning. An example of this stage is to use the commenting service in Google Docs, to collaborate and share feedback on a particular task. A New Excellent Interactive SAMR Visual, 2012. Other examples could take the form of photo essays, public service announcements, or blogs. Thus, Modification requires significant re-design of how we ask students to address their learning, from passive to active learners. Students have flexibility in choice of who to work with, where and when the learning takes place, and how they will show mastery of their learning. Commonly students work collaboratively (and even outside their peer group) without having to come together into one physical space, sharing their work with the teacher, for frequent formative assessment, and with the optional participation of authentic audience within the school or from outside viewers. (Leimbach, L, 2015)

In the Redefinition stage, technology allows for the creation of new tasks, previously inconceivable (Puentedura, R, 2009) Redefinition moves your students into areas that could not be replicated without technology. (Leimbach, L, 2015)
If this level were placed in Bloom's Revised Taxonomy pyramid, it would probably correspond to synthesis and evaluation as being the highest order thinking skills. Redefinition means that students use technology to create imperceptibly new tasks. An example of the Redefinition stage would be "when students connect to a classroom across the world where they would each write a narrative of the same historical event using the chat and comment section to discuss the differences, and they use the voice comments to discuss the differences they noticed and then embed this in the class website". A New Excellent Interactive SAMR Visual, 2012

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3.7. Models and Application of the Flipped Classroom

3.7.1. Different ways to Flip

Inverting the order of homework and classwork is the only fixed element in the flipped classroom. The format the teacher choses to introduce the material to the students can vary. Some teachers adopting a flipped classroom approach choose to convert traditional face-to-face lectures into personally made lectures. According to Bergmann and Sams (2013), "if you're truly overwhelmed by the idea of creating videos, you can use videos that other teachers have created, search for good ones online, or pair up with a teacher to do a video together in a conversational format." (Bergman and Sams, 2013). The short homework assignment involves any form of pre-class assignments, such as reading quizzes or worksheets to help students better prepare for in-class participation. (e.g., Bonnell & Eison, 1991; Meyers & Jones, 1993; Silberman, 1996). (Hung, H.T., 2015)

According to Strayer (2009),it might be preferable for some teachers to structure a less radical flipped classroom that gives students an opportunity to view course content outside the classroom in a number of different formats, but still include regular lectures followed by a learning activity with homework from a book. The author goes on to say, "other teachers might envision a radical flipped classroom that includes only learning activities in class and the introduction to course con-tent only outside class" (Strayer, 2009, p.192).

However, although most definitions and discussions on blended learning and flipped classrooms emphasize the use of digital technology, flipped classrooms do not necessarily require online components. Bergmann and Sams (2012) describe the most basic implementation of a flipped classroom, as Flipped 101, in which teachers assign students a book chapter on given topic before coming to class and then have students complete the problems during class time using pen and paper, and then assign further problems for out-of-class work. Designing flipped lessons without technology such as the Flipped 101 model can be a possibility to address students with limited access to the internet. (Schell, J, and Mazur, E., 2015). (Schell, J, and Mazur, E., 2015)

In addition, some teachers (such as professor Eric Mazur) actually prefer students to read material from textbooks to gain exposure to content, claiming it is more efficient for the subject of science. (Mazur, 1997) Other teachers use videos made by other teachers as the part of the online component of their classroom. For an extra challenge, teachers can choose to convert traditional face-to-face lectures into personally made lectures, using PowerPoint or screencast presentations with apps such as Camtasia, Explain Everything, and Educreations to draw and explain lessons. These videos can then be uploaded to a learning management system such as Edmodo, Schoology, Haiku, or Blackboard (Keene, 2013). Others may choose to create instructional videos using any lecture capture tools, or select ready-made educational videos from websites or networks (e.g., Kahn Academy, TED, iTunes U, and YouTubeEDU) for learners to study prior to class as lecture replacements, in order to free up class time for active learning activities. The short homework assignment involves any form of pre-class assignments, such as reading quizzes or worksheets to help students better prepare for in-class participation. (Hung, H.T., 2015)

In addition, it is preferable for beginner flipped teachers to structure a less radical flipped classroom that gives students an opportunity to view course content outside the classroom in a number of different formats, but still include regular lectures followed by a learning activity with homework from a book. Teachers who have flipped for some time

might envision a radical flipped classroom that includes only learning activities in class and the introduction to course content only outside class" (Strayer, 2009).

3.7.2 Different Flipped Classroom Models

There are a variety of models that can be chosen tailored to the needs of the coursework, varying from teaching styles, information resources, or student interaction. Regardless the form that the flipped classroom takes on, the goal is to bring a blended learning model of instruction to the students that allows for differentiated instruction for students. (Keene, 2013)

Just the education website EducationDive.com alone highlights 16 examples of flipped classrooms, for students ranging from elementary scholars to doctoral candidates, varying in teaching styles, information resources, student interaction, all tailored to the needs of each particular coursework. There are so many, it is impossible to list all the models of Flipped Classrooms, but these are only seven models highlighted by EducationDive.com. (7 Unique Flipped Classroom Models, 2014.)

The **Flipped 101** model is the most basic implementation of a flipped classroom, defined by Jon Bergmann and Aaron Sams (2012), in which teachers assign students a book chapter on a given topic before coming to class and then ask the students to complete the problems at the end of the chapter during class time using pen and paper, and then assign further problems for out-of-class work (Bergman, J, and Sams cited in Mazur, 2015)

In The Standard Inverted Classroom, students watch video lectures and/or read relevant materials as homework to prepare for class, where they practice what they have learned through traditional schoolwork, with their teachers freed up to provide additional one-on-one support.

In the Discussion-Oriented Flipped Classroom, teachers assign a lecture of any kind, related to the day's subject, (i.e. TED Talks, YouTube videos, and other resources, and class time is then devoted to discussion and exploration of the subject. This approach is geared for context-relevant subjects , such as languages, history, or art

The Demonstration-Focused Flipped Classroom: is especially relevant for subjects such as chemistry, physics, and math class, .that require students to remember and repeat activities, and need to view, rewind and rewatch video demonstrations. In this model, screen recording software is most commonly used to demonstrate the activity in a way that allows students to follow along at their own pace.

The Faux-Flipped Classroom is perfect for younger students for whom actual homework might not yet be appropriate. Instead of at home, students watch lecture video in class, where they can review materials at their own pace, while the teacher with the moves around the room to offer individual support.

The Group-Based Flipped Classroom: Applies Collaborative and cooperative learning teaching strategies which facilitates peer based learning. Students learn material before class. In class, students team up to work together on that day's assignment. This format encourages students to learn from one another, and helps students to not only learn the right answers are but also how to actually explain to a peer why those answers are right.

The Virtual Flipped Classroom, more appropriate for college older students and in some courses, can eliminate the need for the classroom completely. Some college and university professors now share lecture video for student viewing, assign and collect work via online learning management systems, and simply require students to attend office hours or other regularly scheduled time for brief one-on-one instruction based on that individual student's needs.

Flipping The Teacher: Video creation in a flipped classroom is not limited to the teacher. Students can also record videos to demonstrate proficiency. As the highest learning skill is to teach, teachers can assign students to their record practice role-play activities to show competency, or ask each to film themselves presenting a new subject or skill as a means to "teach the teacher". 7 Unique Flipped Classroom Models, 2014, April 29

3.7.3. Active Learning Pedagogies in the Flipped Classroom

Flipping the class is by no means the sole solution to finding the most efficient use of class time, but their flexible quality allows space to use a variety forms of innovative and collaborative-based instruction during precious class time. (Schell, J, and Mazur, E, 2015). The Flipped Classroom thus constitutes just a small a part of a larger inquiry or instruction cycle, overlapping with other active learning instructional tools and pedagogies. (Bennet et al, 2013), from the use of clickers to PBL, from studio courses which blend the laboratory and lecture environment to service-learning in the community, and from peer-led instruction. The common element is that they are all student-centered and rely upon active rather than passive participation of students in their learning. (Schell, J, and Mazur, E, 2015).

The spirit of the Flipped Learning is to shift the attention of the class away from the teacher's lecture, and directing the center of class to students engaging in active learning. Afterall, The Flipped class is about pedagogy and not technology. (Mazur, 2015,)

The following are a non-comprehensive list of effective commonly used active learning pedagogies that teachers can choose to use their class time activities. It is important to note that there list is, and there are many more.

Active Learning is the process in which students engage in a learning activity that forces them to reflect upon ideas and how they are using those ideas, thus attaining of knowledge by participating or contributing. The activites require students to regularly assess their own degree of understanding and skill at handling concepts or problems in a particular discipline. The process of keeping students mentally, and often physically, active in their learning through activities that involve them in gathering information, thinking, and problem solving. . (*The Greenwood Dictionary of Education*., cited in Michael, Joel, 2006)

Student-Centered Instruction (SCI) is an instructional approach which places the student (learner) in the center of the learning process. The students are the ones that influence the content, activities, materials, and pace of learning, while the instructor merely provides students with opportunities to learn independently, coaching them in the skills they need to do so effectively. The SCI approach involves substituting active learning experiences for lectures, assigning open-ended problems and problems requiring critical or creative thinking that cannot be solved by following text examples, involving students in simulations and role plays, and using self-paced and/or cooperative (team-based) learning. When implemented properly, SCI can lead to increased motivation to learn, greater retention of knowledge, deeper understanding, and more positive learning attitudes. (The Greenwood Dictionary of Education., cited in Michael, Joel, 2006)

The surge in interest in active learning pedagogies in the late twentieth century stemmed from a growing literature showing them to result in improved learning outcomes for students in terms of cognitive achievements and retention. (Poe, 2015)

A substantial body of research on student-centered, active learning strategies supports the effectiveness of these approaches in increasing student learning and achievement). Active learning is associated with improved student academic performance (Hake, 1998; Knight

& Wood, 2005; Michael, 2006; Freeman, 2007; Chaplin, 2009), and increased student engagement, critical thinking, and better attitudes toward learning (O'Dowd & Aguilar-Roca, 2009). Moreover, misconceptions are significantly reduced.

Research indicates that compared to those in traditional lecture-based classes, students in active learning environments show improved retention and better conceptual understanding of learned material (Sezer, 2011). These results are attributed to the contrasting roles of passive and active learners in the educational process. While passive learners exist solely as receivers, active learners are full participants in the process, allowing them to add to their retentive capabilities through continued self-reinforcement (Petress, 2008).

Though shown to be effective once established, active learning environments are not generated spontaneously. Teachers must work to develop these environments through the use of proper motivational strategies and active promotion of social interaction. (Mazur, 2015)

Inquiry-Based Learning

By this method of questioning-answering, questioning-answering, we seek to develop in you the ability to analyse that vast complex of facts that constitutes the relationship of members within a given society. Prof. Kingsfield in "Paper Chase"

Cited in Lamba, R. S. (2015).

Inquiry-based projects are another way to get students to think critically rather than memorizing information. Implementing these group projects helps students to build important skills such as communications, team work, critical thinking and problem solving. Technology can contribute to these projects and skills, though the supplementary creation of web sites, blogs, and multimedia presentations. The internet can also be a beneficial as a resource. They can connect with students at other schools and do collaborative work with them. They also learn technology skills while doing these projects. (Whitefield, Ragan, 2011)

With the *inquiry* method of instruction, students are led to understanding concepts for themselves, and the responsibility for learning rests with them. The teacher acts as the catalyst, directing students' interaction, activities, and discussions rather than serving as the source of all information. *Inquiry* simply allows students to discover information new to them, through their own curiosity and questioning. It does not lead to discovering new things that have not been studied before. The important aspect is how students reached these reasoning processes to get to the final result.

In inquiry-based teaching methodology, the professor acts like a choreographer, to enliven facts, rather than to be the source of information. The professor raises questions, and guides and promote reasoning and interaction in the classroom. (Lamba, R. S. 2015).

The Learning Cycle

An Inquiry-based instructional strategy is a student-centered approach which uses the *learning cycle* . The learning cycle is a three-staged methodology: exploration (E), invention (I), and application (A). In the exploration stage, students collect data to invent (derive) the concept, and finally, in the application stage they apply the concept to new situations.

The Learning Cycle is based on Jean Piaget's theory that claims that human beings have mental structures and sensorial mechanisms that interact with the environment. The interaction in the exploration and the concept invention stages help students to retain a concept from the classroom information, which allows them to accommodate that information into their existing mental structures. Then, during the application stage, students organize and reinforce the concepts they have just derived with concepts already existing in their mental structures. Activities that allow the student to understand the relationship between that which is already known and newly acquired information reinforce pre-existing knowledge. . (Lamba, R. S., 2015).
The learning cycle, the inquiry-based strategy, and Piaget's theory of cognitive development are connected, where the (exploration) is assimilation, I (invention) is accommodation, and A (application) is organization. This works because the sequence of instruction in inquiry is consistent with how students learn according to a constructivist model like Piaget's cognitive model. (Lamba, R. S., 2015).
According to Alex Johnstone, humans have a filtration system that enables them to ignore a large part of sensory information and focus upon what is important Filtering information is positive for humans, because it helps to recall that which is vital and what is not.. When the newly obtained knowledge connects with the already stored information and builds upon it, it is easily recalled, thus allowing the process of learning to be more efficient and to be applied subsequently to new situations. (Lamba, R. S., 2015).

Highschool teacher Ramsey Mussalam developed an Inquiry based learning model, based on the theory of Experimental Cycles of Learning- Explore Flip Apply. Based on Karaplus' Learning Method, this model involves three main phases: Phase 1) Student Exploration; 2) Content Explanation; 3) Content Application. (Mussallam, 2013)

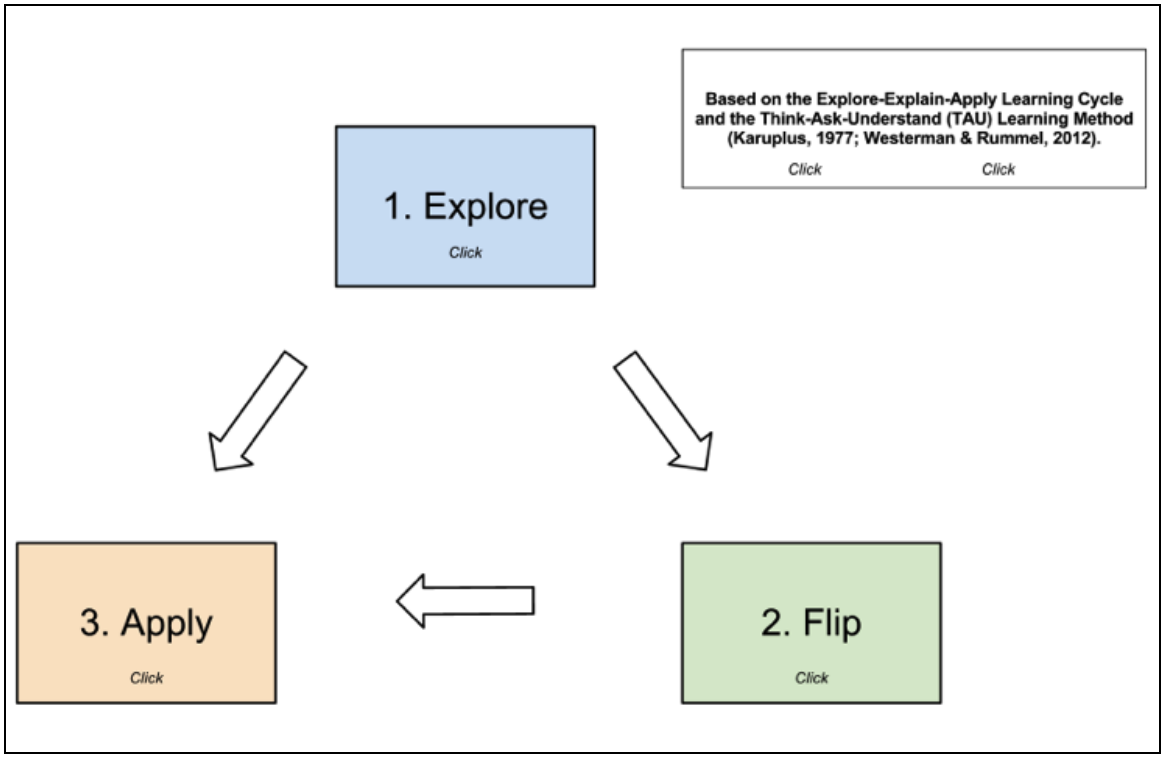


Figure Based on Explore-Explain-Apply Learning Cycle and the Think-Ask-Understand (TAU) Learning Method (paruplus, 1977, Wesermann&Rummel, 2012) ***

Mussallam developed this pedogical approach based on the question: How is the information constructed? Professor Eric Mazur answers this question eloquently, noting that teaching is a two part phenomenon: first transfer of information, second information assimilation. Mazur suggests that the quantifty of information for today's student naturally changes the role of the modern teacher from one of a medium of information transfer, to one of a facilitator of information assimilation (Mazur, 2009 cited in Mussallam, 2013). In addition to asking how is it constructed Mussallam adds on to say that not only the location of assimilation be flipped, but also the timing, of when the assimilation happens. (Mussallam, 2013)

Mussallam defends: "Rather than view transfer and assimilation as a "one-two punch", I propose we ask students to engage in the process of assimilation initially, or as a colleague of mine says, "the mess of discovery", allowing subsequent transfer events to be directed, tailored, and most importantly, driven by student misconceptions, not teacher choice. (Mussallam, 2013)

So how does the Explore-Flip-Apply model work? Generally, it starts with a guided question, like "What qualities create good non-fiction writing?" followed by an activity, in students compare examples of good writing and determine the qualities of good writing based on those samples. *(*Morris, Cheryl, 2012)

In the **Explore** phase, the teacher present students with a problem or question, which they work to find the answer. The objective is to spark students' curiosity and to lead them to find the answer and start building a schema for the topic. Ideally, students would understand many of the concepts without the teacher giving them any information.

The **Flip** phase can involve any kind of flip, be it the traditional flip- a targeted

remediation, a pre-made video, or a screencast. In this phase, the focus is on the skills/standards/information students will need to fully understand the concept and fill the gaps in their constructed knowledge. (Morris, Cheryl, 2012)

In the final **Apply** - phase, students use the knowledge they have constructed along with the knowledge the teacher has delivered via video to work on a real problem, or create a new situation to demonstrate their knowledge. In the writing example above, a possible activity could involve students writing something that demonstrates all the qualitites of good writing, and then evaluate themselves or peers based on a rubric you develop (or even that the students develop)- followed by assessment and reteaching as needed.. (Morris, Cheryl, 2012)

With this new method, let student inquiry drive the learning process. In the *Explore* phase, the teacher uses a hook (video, document, map, guiding question) to activate the students prior knowledge while withholding information from the students, which stimulate their own learning.

Versions of The Learning Cycle

Dr. Jackie Gernstein also refers to the Flipped Classroom as a cycle of learning model. Gernstein provides a unique explanation of the Flipped Classroom Model, a model where the video lectures and vodcasts fall within a larger framework of learning activities. It provides a sequence of learning activities based on the learning theories and instructional models of Experiential Learning Cycles

The learning cycles require a context to learning, being intentional with students about the metacognitive process, and the importance of reflection in the learning process. These ideas and the works of John Dewey, Carl Rogers, and David Kolb provide the foundation for a natural and experiential cycle of learning.

According to Dewey, an educative experience is one in which we make a connection between what we do to things and what happens to them or us in consequence. Humans have a natural form of learning even before they are formally instructed- in which they learn much about the world, themselves, and others. Dewey's approach to schooling is based on experience, - by doing and then reflecting on what happened- that learning happens. (Education Encyclopedia, consulted 20/05/2016)
The famous psychologist and a founder of humanism, Carl Rogers, also emphasizes the importance of experiential learning, distinguished two types of learning: cognitive (meaningless)- academic knowledge and experiential (significant)- applied knowledge. According to Rogers, learning is facilitated when: (1) the student participates completely in the learning process and has control over its nature and direction, (2) it is primarily based upon direct confrontation with practical, social, personal or research problems, and (3) self-evaluation is the principal method of assessing progress or success. Rogers also emphasizes the importance of learning to learn and an openness to change. Rogers, C.R., 1994)

David Kolb believed that "learning is the process whereby knowledge is created through the transformation of experience". According to this belief, he conceptualized learning as a cyclical model. In order to achieve effective learning the student must progress through a cycle of four stages: the

1. *Concrete Experience*, in which a new experience of situation is encountered, or an existing experience is reinterpreted.
2. *Reflective Observation* of the new experience, which focuses on any inconsistencies between experience and understanding.
3. *Abstract Conceptualization***,** when the reflection gives rise to a new idea, or a modification of an existing abstract concept.
4. *Active Experimentation***,** where the learner applies knowledge to the world around them to see what results). Kolb's learning cycle is also referred to as the natural cycle of learning by Jackie Gernstein. (McLeod, Saul, 2010)

Peer Instruction

Eric Mazur describes a modified form of the flipped classroom as Peer Instruction(2001). Like the Inverted Classroom approach described by Lage, Platt, and Treglia, the peer instruction (PI) model requires that students gain first exposure prior to class, and uses assignments (in this case, quizzes) to help ensure that students come to class prepared. Class time is structured around alternating mini-lectures and conceptual questions. Importantly, the conceptual questions are not posed informally and answered by student volunteers as in traditional lectures; instead, all students must answer the conceptual question, often via "clickers", or handheld personal response systems, that allow students to answer anonymously and that allow the instructor to see (and display) the class data immediately. If a large fraction of the class (usually between 30 and 65%) answers incorrectly, then students reconsider the question in small groups while instructors circulate to promote productive discussions. After discussion, students answer the conceptual question again. The instructor provides feedback, explaining the correct answer and following up with related questions if appropriate. The cycle is then repeated with another topic, with each cycle typically taking 13-15 minutes. (Brame, C., (2013).

In classifications of pedagogy, Peer Instruction is an "interactive teaching" or "interactive engagement". Like other flipped classroom methods, Peer Instruction involves using a design that includes before-class work to accomplish four goals: 1) help students develop prior knowledge before class; 2) facilitate students' engagement in frequent self-monitoring of their learning states; (3) solicit feedback from students on areas of difficulty, misconception, or misunderstanding; and (4) help the instructor make data-driven decisions to advance learning in the classroom.

Basically, in a Peer Instruction course, class time is organized by different segments of questioning, interactive discussion, and explanation. Instructors pose prepared questions, called ConcepTests, and students think and then formulate an answer to the ConcepTest individually, called round one. Next, students discuss their response with their peers; in round two, students formulate a final response to the question. Finally, instructors bring the sequence to a close through explanation of the concept.

The basic goals of Peer Instruction are to exploit student interaction during lectures and focus students' attention on underlying concepts. Instead of presenting the level of detail covered in the textbook or lecture notes, lectures consist of a number of short presentations on key points, each followed by a ConcepTest – short conceptual questions on the subject being discussed. (Schell, J, and Mazur, E, 2015)

Peer Instruction is a low-threshold pedagogy because it can be implemented with very little effort and without the purchase of any new equipment or technology. Like flipping the classroom in general, Peer Instruction can be used in any discipline, with small or large class sizes, and with students at any level of preparation. We recommend instructors take an agile approach to using Peer.

Just in Time teaching (JiTT) is a research-based teaching methodology for motivating students to prepare for class by doing warm-up activities online. A common implementation can be exemplified when students have to complete as a reading assignment and then answer at least one question to test students' conceptual understanding and at least one open-ended question where students have the opportunity to provide qualitative feedback to their instructor on points of confusion or difficulty. Warm-ups are scored as low-stakes, not counting for a significant portion of students' grades. The feedback cycle is the main feature of a JiTT course design, in which instructors use students' responses to warm-ups to focus in-class activities on the subject matter students indicate they find most confusing or difficult. According to JiTT co-developer Andrew Gavrin, warm-ups can be used in a variety of ways, for example, to frame a big idea, to "promote the understanding of visual representations", (Schell, J, and Mazur, E, 2015)

Problem-Based Learning (PBL), originally known **as** Learning in a Functional Context**,** is a teaching method in which subject content and methods are learned through activities or problem sets that address a real-world problem. The key feature is that the learning process is initiated by the problem, which ultimately directs the learning. This strategy works best with science classes, and is recommended by the American Association for the Advancement of Science (AAAS). Students are presented with problems to completely new material and context, and it is up to them to search the information and skills in order to solve them. They must seek out for themselves material that is relevant to the problem, locate its sources, and develop strategies for its use. This search of material that must be learned defines the curriculum. The students are the ones who realize, on a need-to-know basis, the reasons for including certain material in the curriculum. Teachers can still supplement students with more conventional, teaching methods of teaching if necessary. In this process, the desired outcomes of enhancing and integrating knowledge, developing problem-solving strategies, generating the skills and motivation for continued learning, and gaining confidence in the assessment of one's own work can be achieved. (Poe, Judith C., 2015)

Team-Based Learning is an evidence based collaborative, cooperative learning teaching strategy designed around units of instruction, known as "modules," taught in a three-step cycle: Preparation, In-class Readiness Assurance testing, and Application-Focused exercise. During class time students work through problems (or case studies) in permanent teams, consisting of about six students each. After responding to problem questions individually, students then respond to the same questions as a team. The fact that grades depend on both individual results as well as their team performance on these quizzes, serve as an incentive for students to engage with the material on their own as well as with their team. Class discussions are also fueled by this individual and team work. (Cooperative learning, 2013) A class typically includes one module.

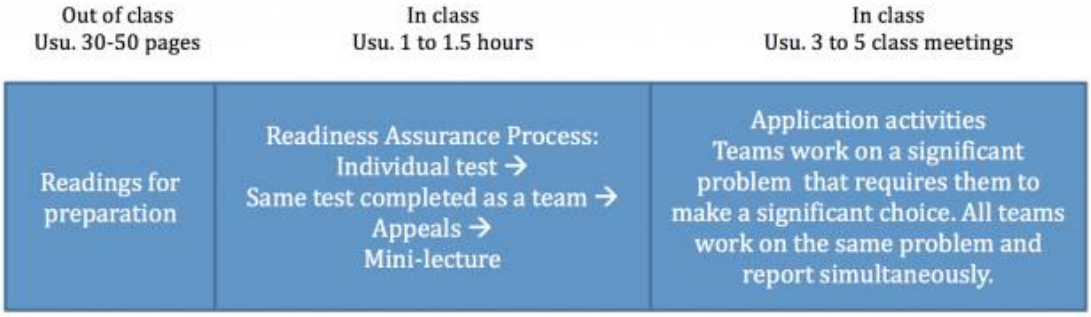


Figure Structure of a team-based learning module, Consulted 13/05/2016, Retrieved from https://cft.vanderbilt.edu/guides-sub-pages/team-based-learning/

For the in-class component, students are organized strategically into diverse teams of 5-7 students that work together throughout the class. Before each unit or module of the course, students must learn the preparatory materials before a class (usually by reading), as the at home component of the Flipped Classroom. In the first class of the module, students participate in the "Readiness Assurance Process," (RAP), where students complete a test individually: the "Individual Readiness Assurance Test,"(iRAT), and then complete the test with their group members (the "group Readiness Assurance Test," (gRAT), both of which contribute cumulatively to students' grades. The tests are typically multiple choice, and are often completed using a "scratch-off" sheet, where students score themselves, reducing grading time *and* promoting student discussion of correct answers.

After the students complete the group test, the instructor encourages teams to appeal questions that they got incorrect. The appeals process encourages students to review the material, evaluate their understanding, and defend the choice they made. To conclude the Readiness Assurance Process, the instructor gives a mini-lecture that focuses on concepts with which students struggled the most. (Brame, Cynthia J, Consulted 13/05/2016)

The rest of the class session is taken up with exercises that help students learn how to apply and extend the knowledge that they have pre-learned and tested. Teams are given an appropriate problem or challenge, and must arrive at a consensus to choose a "best" solution out of options provided. Teams then display their answer choice, and the educator facilitates a classroom discussion between teams to explore the topic and the possible answers to the problem. (Brame, Cynthia J., Consulted 13/05/2016)

This structure promotes meaningful learning, because it requires the teams to make a specific choice about a significant problem requires teams to articulate their thinking, and gives teams an opportunity to evaluate their own reasoning when confronted with different decisions that other teams may make. TBL. Moreover, the fact that all teams work on the same problem and report their decisions simultaneously is a key component. Peer evaluation is crucial to team-based learning, as it is essential to keeping students accountable to their teammates, and is the most important element of assessment. (Brame, Cynthia J., Consulted 13/05/2016)

Test-enhanced Learning: Retrieval Practice

Test-enhanced learning is the idea that the process of retrieving information from memory- remembering concepts or facts- increases long-term retention of that new knowledge. This method, also known as the testing effect, is based on common cognitive psychology research, which essentially claims that what promotes learning are the prompts to promote retrieval versus passively studying material. (Brame, C. J et al, 2015) It is commonly used in the pre-class quizzes of the Flipped Classroom, and is a phase of the individual quizzes applied in the Team-based Learning strategy.

It is important to note that the terms test-enhanced learning" and the "testing effect" can be misleading, if we regard them as high-stakes summative assessments. The "testing" that actually enhances learning is the low-stakes retrieval practice that accompanies study in these experiments. (Brame, C. J et al, 2015)

There are many ways to take advantage of the testing effect, some during class time and some outside of class time. Firstly, in class (or online), teachers can incorporating frequent quizzes in the syllabus, consisting of short-answer or multiple-choice questions, with feedback for the responses. Secondly, instructors can provide summary points during class to encourage students to recall and articulate key elements learned at the last minutes of class can provide significant benefits to their later memory of these topics. (Lyle and Crawford, 2011, cited in Brame, C, 2015)

Thirdly, teachers can apply pre-tests before each unit or even a day of instruction to prime them for learning, by highlighting important information and instructor expectations. (Little and Bjork, 2011 cited in Brame, C, 2015). Informing students about the testing effect is fundamental, to clarify expectations, and underlining the fact that the testing are frequent and low-stakes- and are opportunities for students to practice recall, not to decrease their grade.

The idea that active retrieval of information from memory improves memory is not a new one: William James proposed this idea in 1890, and Edwina Abbott and Arthur Gates provided support for this idea in the early part of the 20th century (James, 1890; Abbott, 1909; Gates, 1917). During the last decade, however, evidence of the benefits of testing has mounted.

A new theory by Bjork and Bjork's posits that memory has two components: storage strength and retrieval strength. Retrieval events improve memory storage strength, enhancing overall memory, and the effects are the most when the retrieval is done at the point of forgetting, This theory aligns with experiments that demonstrate that study is as or more effective as testing when the delay before a final test is very short, because the very short delay between study and the final test means that retrieval strength is very high—an experience many students can verify from their own experience cramming. At a greater delay, however, experiences that build retrieval strength (e.g., testing) confer greater benefit than studying. (Brame, C. J et al, 2015)

Mastery Learning is a pedagogy developed by Benjamin Bloom in the 1950's, that adapted the most powerful teaching aspects of tutoring and individualized instruction to improve student learning in general education classrooms. Bloom and his team believed that nearly all students could reach a high level of achievement, when teachers provide the necessary time and appropriate learning conditions to all students, regardless of their learning rates and modalities. (Guskey, T. R., 2010).

The implementation of Master Learning involves a set of group-based, individualized, teaching and learning strategies based on the premise that students will achieve a high level of understanding respecting their individual learning needs of pacing. Anderson, Lorin W., 1975)

The objective of Mastery Learning involves teaching a unit of material and evaluating students' understanding (at least 90% on a knowledge test) before they can move on to the next unit or learning objective, each requiring about a week or two of instructional time. (Guskey, T. R. 2010). Additional support in learning and reviewing the material is given if a student does not achieve mastery on a test. This cycle will continue until the learner 'masters a concept', and can then move on to the next stage. (Levine, Daniel U., 1985)
Two formative assessments are administered to identify exactly what students have learned and where they need help, the first to check basic understanding. The formative assessment includes *correctives*- explicit, targeted suggestions- that correct students' learning difficulties and to master the desired learning outcomes. After students complete their corrective activities (usually one or two class periods), as second parallel formative assessment is given, targeted at the same learning goals of the unit but with different problems. The second assessment is important to verify whether the correctives successfully remediated the students' individual learning difficulties. It also serves as a powerful motivational tool by offering students a second chance to succeed.

For students who demonstrated their proficiency on the first formative assessment, Bloom recommended teachers give further enrichment or extension activities, as exciting opportunities to broaden and expand their learning. (Guskey,, T. R. 2010).

A large body of research has shown that when compared with students in traditionally taught classes, students in well-implemented mastery learning classes consistently reach higher levels of achievement and develop greater confidence in their ability to learn and in themselves as learners (Guskey, T. R. (2010).

Gamification of learning is also a commonly used pedagogy in the Flipped classroom. Gamification of learning is not the same as Game-based learning, in that gamification of learning does not involve students in designing and creating their own games, or in playing commercially produced video games. Gamification occurs only when learning happens in a non-game context, such as a school classroom, by arranging a series of game elements are introduced to induce learning in the classroom setting. (Werbach, Kevin, 2012). In educational contexts, gamification can induce desired student behaviour such as attending class, focusing on meaningful learning tasks, and taking initiative. (Borys, Magdelena, et. al, 2013).

The Maker Movement is a constructivist pedagogy that has been increasingly popular in collaborative group based flipped classrooms.
Technopedia.com defines the Maker Movement as the name given to the increasing

number of people employing do-it-yourself (DIY) and do-it-with-others (DIWO) techniques and processes to develop unique technology products. Generally, DIY and DIWO enables individuals to create sophisticated devices and gadgets, such as printers, robotics and electronic devices, using diagrammed, textual and or video demonstration. With all the resources now available over the Internet, virtually anyone can create simple devices, which in some cases are widely adopted by users. For example, MintyBoost, a popular DIY USB charger kit built using an Altoids tin, batteries and a few connectors, can easily be created using instructions online, or purchased from other makers who sell their devices. Most of the products created under the maker movement are open source, as anyone can access and create them using available documentation and manuals. However, the maker movement also incorporates creations and inventions that never existed before and were developed by individuals in their homes, garages or a place with limited manufacturing resources. https://www.techopedia.com/definition/28408/maker-movement

Chris Anderson (2012), former editor-in-chief of Wired magazine, defines the movement as "a new industrial revolution." He distinguishes between the maker movement from inventers and entrepreneurs of eras by distinguishing three key characteristics: the use of digital desktop tools, a cultural norm of sharing designs and collaborating online, and the use of common design standards to facilitate sharing and fast iteration. Mark Hatch (2014), CEO and cofounder of TechShop, one of the first and most successful makerspaces, proposes a "Maker Movement Manifesto" that describes makers' activities and mind-sets organized around nine key ideas: make, share, give, learn, tool up (i.e., secure access to necessary tools), play, participate, support, and change. Halverson, E. R., & Sheridan, K. (2014).

The Making Movement in Education

Progressive educators and researchers have been talking for decades about the role of making in learning. Martinez and Stager (2013) credit Seymour Papert as "the father of the maker movement" (p. 17), implying that constructionism is the theory of learning that undergirds the maker movement's focus on problem solving and digital and physical fabrication. Papert's theory of constructionism places embodied, production-based experiences at the core of how people learn (Harel & Papert, 1991). While constructionism has roots in Deweyan constructivism, which frames learning as the product of play, experimentation, and authentic inquiry, the distinguishing feature of con-
 structionism is "learning by constructing knowledge through the act of making something shareable" (Martinez & Stager, 2013, p. 21). Specific tools and programs that have been used in both formal and informal learning spaces are instantiations of Papert's constructionism, including the Logo programming language (Papert, 1980), LEGO Mindstorms kits (Resnick, Ocko, & Papert, 1988), the Scratch programming language (Resnick et al., 2009), and the Computer Clubhouse programs (Kafai, Peppler, & Chapman, 2009). Additionally, educational approaches such as project-based science (e.g., Schneider, Krajcik, Marx, & Soloway, 2002) and problem-based learning (e.g., Schwartz, Mennin, & Webb, 2001) emphasize learning through making. Halverson, E. R., & Sheridan, K. (2014).

3.7.4 Key Elements of the Flipped Classroom

There no defined process of Flipping the Classroom. However, there are some examples of successful flipped classrooms that can be replicated. Dr. Brame, Director of the Center of Teaching, of Vanderbelt University recommends teachers five key elements to flipping the classroom: Providing a variety of material for students to gain first exposure, provide incentives to prepare for class, creating proper assessment mechanisms, implementation of in class activities that engage higher level thinking.

Firstly, it is crucial to provide a variety of material for students to gain first exposure prior to class, varying from a simple textbook readings to lecture videos to podcasts or screencasts. For example, Grand Valley State University math professor Robert Talbert provides screencasts on class topics on Youtube**,** while Vanderbilt computer science professor Doug Fisher provides his students video lectures prior to class. (Brame, C., 2013) The pre-class exposure doesn't have to be high-tech, or even digital. Students can simply complete pre-class reading assignments. For example Professor Eric Mazur prefers giving reading assignments from the textbook. (Mazur, 1997) (Brame, C., 2013)

Secondly, teachers must create incentives for students to prepare for class. In all the examples cited above, students had to complete a task associated with their preparation, with immediate feedback and assessment. The assignment can vary from online quizzes to worksheets to short writing entries, but in each case the task provided an incentive for students to come to class prepared, with the assessment motivation of a point system. In many cases, grading for completion rather than effort can be sufficient, particularly if class activities will provide students with the kind of feedback that grading for accuracy usually provides. (Brame, C., 2013)

Thirdly, it is crucial to create mechanisms of assessment of student understanding. The completion of pre-class assignments are the evidence of their preparation. Moreover, it is important for both the instructor and the student assess their understanding. Pre-class online quizzes can allow the instructor to practice Just-in-Time Teaching, enabling him/her to tailor class activities to focus on the elements with which students are struggling. Most online quizzes are automatically graded, which also helps students pinpoint areas where they need help. Pre-class worksheets can also help focus student attention on areas with which they're struggling, so the instructor can tailor class activities around those areas. In addition, pre-class writing assignments help students organize and clarify their thinking about a given topic, to be better prepared to participate in richer in-class discussions. Much of the feedback students need is provided in class, reducing the need for instructors to provide extensive commentary outside of class. In addition, many of the activities used during class time (i.e clicker questions or debates) can serve as informal checks of student understanding. (Brame, C., 2013)

Finally, the added value of the Flipped Classroom lies in engaging in-class activities that focus on higher level cognitive activities**. S**tudents gain basic knowledge outside of class, so that they can spend class time to promote deeper learning. The types of activity obviously depend on the learning goals of the class and the culture of discipline. In some contexts, students may spend time in class engaged in debates, data analysis, or synthesis activities. For example, while Mazur and colleagues commonly focus class time on student discussion of conceptual questions and quantitative problems focused on physical principles, while Lage, Platt, and Treglia described experiments students did in class to illustrate economic principles, The key is that students are using their new knowledge, deepening their understanding and increase their skills in class activities. (Brame, C., 2013)

3.7.5. A suggested Three-step process to Flipping

Professors Julie Schell and Eric Mazur define a successful flipped classroom as a three-step process that shifts the traditional model from an instructor-centered to a student-centered learning environment. These three phases are also tied to three big ideas that Schell and Mazur believe educators need to embrace when adopting a flipped classroom.

1. Before class, students gain first exposure to content via text, video, DVD, or other medium of direct instruction, in order to develop deeper subject-matter knowledge, to prepare students for the kind of thinking about the subject-matter that they need for the in-class activities. This phase should not be considered homework. This phase is attached to the idea that a successful flipped classrooms require facilitating students' development of surface-level prior knowledge before they attend class so that they are prepared for the more rigorous work of experiential and deep learning during class time. (Schell, J, and Mazur, E, 2015) In this way students get a basic understanding of a concept, in order to be prepared to apply this newly gained information for in-class student centred activities, and projects. (Taylor, Adam, November, 2016,)

2. During class, students spend class-time learning collaboratively through experimental activities, with frequent feedback from peers and instructor. Instructors should select activities that require students to engage in higher order cognitive tasks such as application, analysis, and apply their knowledge in different contexts. This phase is tied to the proven idea that people learn best when they are engaged, and when they are provided with opportunities for social and/or experiential learning, including intellectual interactions with peers and faculty. (Astin, cited in Schell, J, and Mazur, E, 2015) Classrooms now look like laboratories or studios, for tackling difficult problems, working in groups, researching, collaborating, crafting and creating. (Taylor, Adam, November, 2016,

3. After class, students solidify their understanding, by following-up on the feedback they receive from in-class from peers and instructors to direct their practice in the areas where they need the most work. In addition, instructors use provide additional learning activities to engage students in self-directed learning. This phase is often ignored in flipped classroom literature. This phase is tied to the third big idea that learning is a continuous process that continues even after class, as students engage in self-regulated learning activities. (Schell, J, and Mazur, E, 2015)

3.7.6. Tools in the Flipped classroom

Although there is no fixed formula to flip a classroom, as each class and instructor and styles are unique, reports on flipped classrooms have been compiled, resulting in a a list of tools that generally characterize a flipped approach. (Egbert, J., et al, 2015).

Digital lectures, providing instructional videos created by the teacher, students, or someone else, are made available to students online for easy access outside of class are key element of flipped instruction.
Many instructors choose to use a Course management system (CMS), to assist in the management of educational courses for students. CMSs can be used to store course syllabi, present course announcements, manage student email, provide online discussion, support online submission of assignments, and host teacher- and student-posted videos.

CMSs can be an important aspect of some, but are not required (Strayer, 2007, cited in(Egbert, J., et al, 2015).

Many instructors prefer to include the use Textbooks and outside texts as one of several resources provided to students, to complement the videos and other resources for out-of-class preparation. In other classrooms, the instructional videos replace textbooks completely.

Group discussions and group work. Teachers who require students to bring lecture-related questions to class often began class with a discussion of those questions (Bergmann, S., Sams, A 2012), designed to clear up any confusion or misconceptions that may have come from the using the videos and/or resources. Another common task during class time in many flipped classrooms is group work and/or lab activities. These tasks provide opportunities for collaborative learning and problem-solving as students share perspectives and gain insights that they might otherwise be unable to obtain on their own. (Egbert, J., et al, 2015).

Mini-lessons. Mini-lessons can be based on student-generated questions and group discussion. If enough students have the same question after interacting with class resources, the teacher may briefly reteach that particular aspect of the lecture (Bergmann & Sams, 2012; Lage, Platt, & Treglia, 2000; Strayer, 2007).

Differentiated pacing and timing. In some flipped classrooms, students work at their own pace, so not all students are working on the same task at any given time. For instance, teachers may group students based on the task that they are currently working on, which allows students to have peer support while giving them the freedom to work at their own pace. This technique allows teachers to more effectively address student needs, as students in a particular group may be struggling with similar concepts from a given lesson (Bergmann & Sams, 2012).

3.7.7. Digital tools

Resources such as Khan Academy allow teachers who lack the necessary tools to create their own instructional videos and access a bank of thousands of instructional videos for students. Students who interact with Khan's online activities along with the LMS discussion boards will be primed and ready to return to school the next day for further facilitation of instruction with the teacher. (Keene, 2013)

PowerPoint or screencast presentations, create instructional videos using any lecture capture tools (Hung, 2015). For an extra challenge, teachers can make their own videos using screen capture apps such as Camtasia, Explain Everything, and Educreations to draw and explain lessons. These videos can then be uploaded to a learning management system such as Edmodo, Schoology, Haiku, or Blackboard. (Keene, 2013) .Teachers can also simply select ready-made educational videos from websites or networks (e.g., Kahn Academy, TED, iTunes U, and YouTubeEDU) for learners to study prior to class as lecture replacements, in order to free up class time for active learning activities. (Hung, 2015)

3.7.8. Assessment

Since the majority of class time is spent on active learning, instructors actually teaching in a completely different way. Teaching differently requires new approaches, tools, and strategies, and as a result, a change in the lesson planning process and the assessment process will also change.

Assessment in the flipped classroom may take place online, in the classroom and/or in an authentic setting. Fisher and Assa-Eley, 2013 concluded that student examination performance on questions presented explicitly during in-class exercises was better than for questions that were not directly presented in class. , cited in Estes, 2013)

Assessment in the Flipped Classroom varies according to the pedagogies applied in class. For example, an assessment for a Project –Based learning will be different from the Team-based learning, or Inquiry-based learning, or Mastery Learning. Thus, the teacher must define in the syllabus, how each objective will be evaluated clearly beforehand. One main difference from the traditional class is that assessment in the Flipped Classroom is on-going, versus solely based on summative tests like in the traditional classroom. Thus, the assessment must also suffer an inversion.

In order to see who has watched the video, and have grasped the concept enough to continue with the activities of the day, the teacher provides a quiz- either after they watch the video, or at the beginning of class. The results of the quiz, allows the teacher to understand what ideas may have been misunderstood for clarification. In this way, the teacher can address the problem easily and then move on. (Adam, Taylor, 2010)
Another way for the instructor to understand if students did the pre-class work, and more importantly, that they have a good understanding of the concepts, is the **In-class Readiness Assurance Testing** (RAT), where students complete an individual readiness assurance test (IRAT), consisting of 5 to 20 multiple choice questions. If the instructor uses team-based Learning model, after this individual test, students then take the same test, with their team. This test approach that counts for assessment is important, as it gives students a real incentive to learn materials beforehand, attend classes, and contribute to team discussions. The readiness assurance process holds students accountable for coming to class prepared and working together as a team (Brame, C., 2013).

Assessment can be more or less complex according to the pedagogy applied in the Flipped Classroom. For example, in the Team-based Learning, L. Dee Fink uses a method in which students are given 100 points to distribute among their teammates (but don't evaluate themselves). Based on all team members' evaluations, a student is assigned a score (out of 100) that is used as a multiplier for the score they receive for group activities. Thus, if a team member does not contribute to group activities, her or her score for the group activities will suffer, while a team member who contributes very effectively benefits. (Brame, C., 2013).

Larry Michaelson uses a variation of this method in which a student evaluates the other members of her team and distributes a set number of points among them. The points the students receive from each of their teammates determine the peer evaluation score that is a direct component of their grade for a given module.
Finally, the Paul Koles method combines the two approaches and includes grading of the comments students provide for their teammates. (Brame, C., 2013).

4. Research Methodology

4.1. Introduction

This study, guided by the question "What are the possibilities and limitations of the implementation of the Flipped Classroom model in education, specifically high school and university, explored possibilities and limitations of this blended learning model, through the personal insight of professionals in the field. Since the nature of this thesis is exploratory, a qualitative research method was chosen to address this broad question, through the Content Analysis of the Interviews to leading experts in the field, who can give personal insights and in depth perspectives of experienced professionals actively implementing the Flipped Classroom in reputable schools. According to Fraenkel &Wallen (2015), content analysis is a convenient tool that allows the investigator to study the human behavior in an indirect way, through the analysis of their communications. The data collection method chosen was the in-depth interview, for its reliability and validity of material and data collection. Finally, an interview guide was developed to direct the semi-directive interview, and at the same time giving the respondents freedom to talk about concerning issues.

Despite its popularity in academic press, the reality is the Flipped Classroom methodology and attitude towards teaching is relatively unknown in most public schools around the world. Most teachers still adopt the traditional classroom setting, both students and parents also tend to think this is the only model of education. The most logical approach would be to choose a quantitative analysis research approach, which would involve implementing a flipped course (ESL) and evaluating the test results before and after, and measuring the results through a satisfaction questionnaire. However, upon second consideration, a qualitative exploratory research analysis was chosen for this study, with the intention of clarifying some common misconceptions of the blended Flipped classroom model.

The term that describes this study is 'semi-structured qualitative study' (SSQS) using qualitative approaches, involving semi directive interviews. What characterizes the SSQS is it has some explicit structure, in terms of theory or method, but that is not completely structured. This kind of study involves systematic, iterative coding of verbal data. In contrast with the quantitative research, most commonly conducted through a controlled experiment, where data is known with certainty, through a hypothesis, independent variable, dependent variable, power of test, choice of statistical test, number of participants; in this kind of study there is no hypothesis, although there is a question, or research problem – where the themes that emerge from the data may be very different from what the researcher expected, and where the individual personalities of participants and their situations can influence the progress of the study and the findings. (Blandford, Ann 2013).

To this end, some of the top high school and university instructors, and researchers known for their experience in the Flipped Classroom were interviewed, to share their proven experience, personal insight, and advice. The interview was chosen for several reasons. First, interviews have the capacity to generate rich, valid data. Secondly, the language use by participants was considered essential to gain insight into their perceptions and values, and thirdly, to help understand the contextual relational

aspects. (Newton, N., 2010). Moreover, exploratory interviews seek to develop hypothesis rather than collect facts and numbers. Moreover, an interview (when handled correctly), can capture the richness, depth, sincerity and honesty of the experiences of the interviewees. (Oppenheim (1992, cited in Cohen, 2013)

4.2. The Semi-Directive Interview

Interviews can range from less to more structured. In a completely structured interview (i.e. a questionnaire), all questions are predetermined, while a completely unstructured interview is more like a conversation, but with a particular focus and purpose. Semi-structured interviews fall between these two categories, in which questions, or themes, are planned ahead of time, but with certain freedom to pursue subjects of inquiry as they come along, to follow up on interesting and unexpected avenues that emerge. (Blandford, Ann 2013).

In terms of interview, the semi directive interview was chosen. This kind of interview falls into the formal category, where the interviewer uses an 'interview guide, which he/she develops using a list of questions and topics that need to be covered during the conversation, usually in a particular order. Semi-structured interviews are best used when the interviewer has one chance to interview someone (Bernard, 1988, cited in Cohen, C, 2006). This was the case in this study, in which all interviews were done once via internet, with the exception of one interview which was done twice due to connection difficulties.

In addition, the interviewees have the freedom to express their views in their own terms. (Cohen, 2016). The invaluable quality of the semi structured interviews is that they provide rich, original voices which can be used to construct research narratives (Gomm, 2004, cited in Nigel, N, 2010). In turn, the interviewer should allow the flexibility of allowing the respondent to go off tangent, and talking about information that may be new and useful for the research. This was especially valuable in this exploratory study, as all of the interviewees were highly knowledgeable university professors and researchers. Throughout the course of the interviewing, it was very useful to learn to follow other topics the respondents introduced, as it opened up new door and possibilities to the study, which had not been planned.

Semi-structured interviews are often preceded by observation, informal and unstructured interviewing for the researchers to develop a clear understanding of the topic of interest necessary for developing relevant and meaningful semi-structured questions. (Cohen D, 2006). In this study, all of the interviews were preceded by an in depth research of each of the individuals. In addition, an informal interview was done to one of the participants, who was recommended by one of the professors on the list. This was quite helpful to get a clearer understanding of the context, and also to prepare for further questions. To another candidate, written questions were also sent in advance. However, in person interviews were more deep and complete, thanks to the two-sided interaction, and the opportunity for the researcher to properly introduce the context of the study.

On the other had, there are some of the weaknesses of to the semi-directive interview. The so-called *interviewer effect*, when people respond differently depending on

how they perceive the interviewer, might have a bearing on the amount of information people are willing to divulge and their honesty about what they reveal. (Denscombe, 2007 cited in Nigel, N, 2010). In addition, comparability can be reduced due to difference in sequencing and wording each interview. However, each person- and interview- is unique, with his or her own style. What is potentially lost here is gain by allowing interviews to develop their own coherence, which itself can be analysed. (Nigel, N, 2010)

4.3. The Interview Guide

Typically, the interview has a paper-based interview guide that he or she follows. (Cohen, 2006). The Interview Guide provides a clear set of instructions for interviewers and can provide reliable, comparable qualitative data. (Cohen D, 2006) The guide is basically an outline for the whole interview, dividing the conversation into categories, outlining the topics and issues to be covered. The fact that the guide is written in advance, allows the interviewer to decide the sequence and wording of the questions ahead of time (Cohen, et. al, 2013). In this case, the interview was divided into six categories, which guided the investigation and provided the framework for the study:

Introduction	**Background and Definition**	**Application**	**Pedagogical practices**	**Pros and Cons**	**Future Directions**

The main advantages of applying an Interview Guide is that it outlines the direction of the interview, allowing more structure and organization. The fact that the questions are made in advance allows for more peace of mind, and consequently the interviews tend to be more relaxed, conversational and situational. In addition, it increases the comprehensiveness of the data and also helps makes organize the data collection somewhat systematically for each interviewee. Since it is made in advance, logical gaps in data can be anticipated and closed. Most importantly it is the categorization process that helps organizes the questions topics, to facilitate the data analysis at the end. (Cohen, 2013)

Although the interviewer follows the guide, whenever necessary, he or she can choose to follow topical trajectories in the conversation that may slightly deviate from the guide. Having too much structure can also potentially limit the flow of the conversation. The reality is that it is impossible to know everything in advance, and inevitably there are lots of things the researcher is not aware of. (Cohen D, 2006).

Another disadvantage of this is the interviewer flexibility in sequencing and wording questions can result in substantially different responses, thus reducing the comparability of responses. (Cohen 2013) If precautions are not made, important topics may be omitted by mistake. It is up to the ability of the interviewer to balance this dichotomy. (Cohen, 2006)

Interview Guide

Exploration of the Flipped Classroom: Possibilities and Limitations

Purpose: To analyze the possibilities and limitations of the Flipped Classroom Blended learning model applied by a variety of instructors/ researchers specialists in the area.

1. Analyze the differences/similaries in definition of the Flipped Classroom model in teaching and the way they were introduced to it
2. Identify the different application, including planning and assessment of the different Flipped classroom models applied by the different instructors
3. Identify common innovative pedagogies that can be applied in the flipped classroom, and the different elements that characterize their particular pedagogic practices in the flipped classroom
4. Identify the elements, including advantages and disadvantages of the flipped classroom, as well as the different which instructors believe

5. Characterize, and understand the future perspectives of the Flipped Classroom Model according to professionals.

Target group: Instructors of High school and University levels, as well as Researchers who use and/or do research on the Flipped Classroom model

Block 0	**Block 1**	**Block 2**	**Block 3**	**Block 4**	**Conclusions**
Introduction	**Background and Definition**	**Applying the FC**	**Pedagogical practices**	**Pros and Cons**	**Future Directions**
Identify interviewee; - Contextualize the research-objective and importance - talk about organizationa nd colaboration (advisor, school, etc) - Guarantee that interview will be used for academic purposes only - Guarantee privacy - Inform the duration and the recording of the interview session	-How long have you been integrating Digital Technology in the classroom? -Do you think it enhances learning? What is the role of Digital Technology in Education in the XXI century? -Many argue the FC is not a methodolog y, but merely a way to be more efficient with class time. What is your definition for the Flipped Classroom? -There are also different models of Flipped Classroom? Which one do you	-How did you start flipping, and why did you choose to Flip? - What preliminary preparation was necessary for you to Flip the classroom (in terms of class organization, preparation, awareness of student, and families) - How did the Flipped classroom change your role as a teacher? How? - What kind of assessment do you adopt? How does it work? How do the students react to it? - What advice or tips do you have for schools or teachers attempting to flip for the first time?	How do you use the class time of your Flipped Classroom? What active learning pedagogies do you apply? Do you apply more than one? What digital tools/ resources did you use? Why and how do they work? -What results did you have after the first time in terms of student learning?	What are the possibilities and most important benefits of Flipping the classroom? What mains roadblocks did you experience throughout the years? Were you successful the first time you flipped? What problems/obstacl es/difficulties did you feel the first time? The Flipped Classroom isn't for everyone- to what group/category do you think it is best fit for? What impact did it have on your institution? How do you deal with resistance among students? parents? Faculty?	In your view, what are the future perspectives for the Flipped classroom? In your professional experience, where have you seen the Flipped Classroom successfully implemented ? What future perspectives do you see for the flipped Classroom? Do you think it is a tendency or is it here to stay?

	adopt and why?	In your personal experience, what conditions do you need to Flip the Classroom? What preconditions are favorable? Are there any context/situations /conditions does the Flipped Classroom not work well in? Unfavorable? What are the difference in application of the model with different subjects? For example languages vs the sciences?		Administration? For students used to the traditional classroom What is a bad flipped classroom in your eyes? How can it be improved?	

4.4. Stages of the Research

The research strategy for this thesis began by gathering information regarding the Flipped Classroom key words search. There was a lot research resulting from that search-articles, blogs, websites, academic journals, from which categories was made with the most important topics related to the Flipped Classroom. From the information collected from the research from the Literature Review, six categories mentioned above were chosen: Introduction, Background and Definition, Application, Pedagogical Practices, Pros and Cons (Possibilities and Limitations), and Future Directions. These would be the categories from which the questions for the Interview would be formed, to be later analysed and compared with the literature review.

The first category corresponds to the introduction of the interviewer. The second category, regards the background of the interviewee and his or her definition of the Flipped Classroom. The Application category regards to the description of how to apply the Flipped Classroom, according to different professionals. The Pros and Cons category regards to the Possibilities (advantages) and limitations (disadvantages) of the Flipped Classroom. And finally the Future Directions regards to the prediction of what the future of this methodology in the greater scheme of events.

From extensive readings on the articles, a list was made of 20+ of the most important names of professionals currently implementing or researching the Flipped Classroom model. From that list, formal invitations were made via email, from which ten professionals responded positively, and scheduled between the months of December and January. Only one interview was redone, due to technical internet connection difficulties.

The next phase of the exploratory investigation, was the development of the Interview Guide, fundamental to structure the interview. The idea was the information collected from the Literature Review, would correspond in general with in the data collected in the Interviews.

4.5. The Interviewing Phase

With the Interview Guide complete, the interviewing phase began. Incidentally, the interview phase corresponded very conveniently with December and January, a period when most professionals in education are on Christmas holiday, when instructors were more available.

4.5.1. The Interviewees

In order to draw general conclusions, a minimum of five interviewees was needed in order to have a complete content analysis. Thankfully, ten interviewees accepted the invitation to participate in this study. In this study, the names of the participants would be included, as they were influencers in the field, and they wanted to be recognized for their contribution. The following list is in chronological order of participation: Dr. Eric Mazur, Dr. Helaine Marshall, Dr. Adelina Moura, Dr. Brian Bennet, Dr. Thomas Arnett, Dr. Craig Roberts, Dr. Marc Sperber, Dr. Idalina Sousa, Dr. Ana Rita Mota, and Dr. Ken Bauer,

Ten individual interviews were conducted with professors, instructors and researchers in the field Flipped Classroom instruction or research: three high school teachers, four University instructors, and one researcher. Five interviewees were American instructors (high school and university), one instructional designer and an educational researcher, three were Portuguese high school teachers and education researchers, two instructors were Dutch (a university professor and a high school teacher), one Canadian university professor.

Most interviews were conducted on recorded Google Hangouts, or Skype calls, except for three, which were done in writing, for convenience of both parties. All interviewees were extremely open, willing to help, with a very positive attitude. Most of the interviews were conducted via video, although some were audio, due to a weak internet connection. In some cases, the video interviews allowed a much livelier interaction with the respondent, as eye contact permitted a more complete interaction. One of the interviewees inclusively admitted having slight hearing difficulties, and admitted video was important for reading lips.

On the other hand, the audio interviews did not hinder the performance of other participants, who many of which seemed to be used to talking to press. Perhaps the absence of a visual allowed for more shy participants to speak with more ease.

Furthermore, many professionals admitted to work daily on Google Hangouts regularly, and were completely comfortable with the format. Three of the participants conducted the interview in writing, due to time constraints on both sides. Writing was not a hindrance either, since it allows for respondents to have the time to prepare and think about each question. All in all, the format of the interviews (audio-visual-writing) did not put at cause the content in any way.

4.5.2. Interviews

Interviews ranged from a minimum of 30 minutes to a maximum 1 hour long, with the exception of one two hour long interview. Firstly, the interviewee explained the purpose of the research and allowed the researchers to develop rapport with participants by asking them to share information regarding their background and interest in flipped learning. Permission was also obtained to provide names (and recognition for their contributions to the Flipped Classroom model), and to record the interviews exclusively for the purpose of this study. Questions were not sent in advance to the participants, with the exception of the written interviews, as the questions were quite general and didn't require previous preparation.

4.6. Content Analysis

After the Interviews were completed, the most important phase was the Content Analysis, in which all the information was to be organized and connected. With a qualitative semi-directive interview, the 5-step method of data analysis developed by McCracken was chosen, to provide a framework to analyse long interviews. Field notes, and analytic memos were used, as well as the table for analysing the coding. Step one involved reading and reviewing each interview transcript twice (the first for comprehension, the second for identifying details. Step two was the analysis, and category creation based on the Literature review, and subsequent creation of a categorization table; Step four involves identified connections and develop pattern codes in categories, and t**he final stage** involved writing up the data, defining predominant themes throughout the interviews, which serve as answers to the research questions.

The final Stage of the Research involved drawing conclusions out of the full content analysis.

4.6.1. Results of the Interviews

The preliminary phase of the content analysis was the creation of the Interview Guide, wherein categories or topics were chosen for each question, to be asked to all interviewees. The questions fell into seven different topics or categories: Background, Definition, Application, Assessment, Pros, Cons, and Future Directions. From these Categories, several patterns emerged from the interviews with the participants who shared similar views concerning the different categories. The categorization can be found in the Appendix section.

The approach used to writing up the findings of qualitative research chosen was to report key findings under each main theme or category, using verbatim quotes to illustrate those findings, followed by a separate discussion chapter in which the findings are discussed in relation to existing research (as in quantitative studies). (Burnard, P, 2004).

Upon analysing the interviews, patterns were noticed in terms of each question. Generally, the interviewees from the same organizations that use the same pedagogies share similar views in terms of their answers to all the categories. There are five main groups of interviewees who shared similar perspectives on the Flipped Classroom, since they belong to the same organization. Also, groups that followed the same pedagogies (for example, Peer Instruction, or Team-based Learning), tended to have more things in common.

The first group is Dr. Eric Mazur, Harvard Physics Professor, his assistant professor, and Physics Researcher, Dra Ana Rita Mota both share a similar definition and application of the Flipped Classroom, as they both apply Peer Instruction and Team-Based Learning, and are members of Mazur Group of Harvard University. The second group is Dr Craig Roberts, Neuroscience Professor and Instructional Designer Dr Marc Sperber, both faculty of Duke University, who apply mainly applied Team-Based and Project-based Learning Pedagogies in class, mixed with some Peer Instruction.

The third group is made up of three members of the Flipped Learning Network, University professor of Linguistics and EF, Dr. Helaine Marshall from Long Island University, high school Science teacher Dr. Brian Bennet at Elkhart Community School Corporation, and Computer Science Professor at Tecnológico de Monterrey, Guadalajara, Mexico.

The fourth group includes Dr. Adelina Moura and Dr. Idalina Sousa, both high school teachers form northern Portugal, who are both a part of the Coimbra University Innovative teacher research group, and apply a mix of Gamification, podcasts, Peer-based learning, depending on the material they teach. The Fifth group has just one member, Dr. Thomas Arnett, who is not an instructor, but an education researcher for the Clayton Christensen an organization, who although does not use the Flipped Classroom directly, but he has studied different applications of this model across the country and shares valuable insight.

Many definitions, for the same thing

There is no one universal definition of the Flipped Classroom. Although each of the interviewees gave their own definition of the Flipped Classroom. That is why there were several initiatives from different organizations to give a simplified definition, such as the Flipped Learning Network (FLN), and the Clayton Christensen Institute of Blended Learning. To the members of the Flipped Learning Network, the Flipped Classroom is defined as *"a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides*

students as they apply concepts and engage creatively in the subject matter. In addition, the Flipped Learning definition, adds the four important pillars of Flip: Flexible Environment, Learning Culture, Intentional Content, and Professional Educator. (Network, F. L. (2014).

Dr. Helaine Marshall, one of the co-writers of this definition, prefers the term umbrella term of Flipped Classroom instead of ambiguous, "*because it encompasses all different subjects and contexts. You can't be too specific with the definition because there lots of contexts- teaching in different subjects. Teaching linguistics is different from teaching high school chemistry, to American literature. That's why we must come up with an umbrella term that can be said for all contexts, versus a restrictive term, which is specific to a particular subject. "In the Flipped Learning definition, the emphasis is on the learning, versus flipping procedures. The Learning is the starting point, with a focus on active, student-centered learning. When the learner can control the video, he/she is in control- what the learner wants.- XXI century learning- when you want to learn something, you go out and find it."* (Marshall, H)

On the other hand, Educational Researcher Dr. Thomas Arnett provides the definition of the Clayton Christensen Institute, which started defining the different Blended Learning models because there was some confusion and debate on how different teachers and institutions did blended learning.

"Different professionals and institutions were mixing digital technology with face-to-face learning in slightly different ways. Rather than having schools debate on who was doing B-learning and in what way, the Clayton Christensen Institute came up with a taxonomy, created through field observation, to have more precision in describing how they were implementing B-learning." (Arnett, T, interview)

According to the Clayton Christensen Institute, the Flipped Classroom is defined as one of the Rotation models of Blended Learning. *" The key distinction of the Rotational Models is that there is online learning and face-to-face learning at a brick and mortar setting happening in conjunction and there is a schedule that dictates when the students move between the online learning and the and face-to-face in class portions of learning. In the Flipped Classroom, the rotation happens between students' homes and their schools. So students do their online learning at home, and then come to school for the face-to-face element of instruction".* (Arnett, T, interview)

Definitions of the experts of the Flipped Classroom

Dr. Eric Mazur from and founder of Peer Instruction pedagogy, believes education is a two-step process: information transfer and assimilation. The Flipped Classroom, or Inverted Classroom, as he prefers to identify it, simply takes the information transfer outside the classroom. "*In class, students do activities to help students assimilate the information. Education is so much more than information transfer. The Inverted Classroom emphasizes the hardest element of teaching, the assimilation stage, and enables students to have more time to the act of learning, which is not a spectator sport. You can't learn by just listening to a teacher, you have to do the learning."* (Mazur, E, interview) In other words, teachers applying the Flipped Classroom should facilitate and encourage Active Learning.

Dr. Ana Rita Mota, who was Mazur's assistant teacher and researcher, further explains that, from the perspective of a teacher (versus that of a researcher), the Flipped Classroom is not restricted to the optimization of classroom time, and when accompanied by other methodologies (such as the Peer Instruction), it enables the students to become co-responsible for their own learning and thus become more autonomous. (Mota, A, interview)

Dr. Helaine Marshall, (from Group 3), one of the co-authors of the Flipped Learning Network definition, also puts the emphasis on the learning, versus the flipping procedures. Marshall prefers the term Flipped Learning, which *"necessitates a dynamic, active engagement of the students in order to work. According to Marshall, Flipping the classroom is not just inverting the order of the homework and the class lecture. (...) "The key change in Flipped Learning is embodied in the word Dynamic." Learning is the starting point, with a focus on active, student-centered learning.* (Marshall, H). *In Flipped Learning, the individual space becomes dynamic. If the instructor chooses to include a video, he or she must insure students interact with that video in real time, either by taking notes or answering questions during the video. In order to work, accountability has to be built in dynamically during the video, or the reading. The main idea is the student must be accountable for having entered in dynamic contact with the material.* (Marshall, H) That is why she creates Just-in-Time quizzes that students must complete actively while they watch the video. Thus, Marshall believes that accountability is a key element for the Flipped Classroom to succeed, thus it must necessarily be embedded into the planning.

Dr. Bennet (also a member of the Flipped Learning Network shares the FLN definition, as "*removing activity from the community space or the classroom space, which can be done individually. So flipping instruction is taking that individual component and putting it back on the students."* (Bennet, B, interview)

Dr. Bauer, (FLN) takes a step further, claiming that the key to a Flipped Classroom is not to merely flip homework and in-class activities but flipping the control of the learning. *Teachers must let go of the control of where the students will go with the learning, and become a guide to learning. To Bauer the biggest change for the students (and the instructors) is the shift of responsibility from the teachers to the students* (Bauer, K, interview)

Dr. Marc Sperber and Dr. Craig Roberts (Duke University faculty) both defend that t*he Flipped Classroom necessitates the active participation of student, made possible by well-structured, built-in accountability and formative assessment into their Problem-based, Team-based classroom activities*. (Roberts, C) Dr. Craig Roberts defines Flipped Learning as shifting the order of the traditional classes *from simply gaining information to mastering information in order to solve complex problems as individuals and teams. Learning happens through the interaction between students, where the teacher becomes a facilitator. The shift also involves shifting the goal of learning from gaining information, to mastering information, in order to solve complex problems.* (Roberts, C, interview)

Dr. Sperber defends that a good flipped classroom *always contains formative assessment, discussion and debate between students, feedback and targeted instruction on the trouble spots, and real-world problem solving.* (Sperber, M) Just like Dr. Marshall, Dr. Sperber believes: *"This is very different than what I hear some people saying about the flipped classroom, which is that students simply do their homework in class".* (Sperber, M)

Dr. Moura and Dr. Santos (both researchers from Coimbra University, Portugal) also defend that the Flipped Classroom encourages autonomous, active learning. Dr. Adelina, a researcher specialized in Mobile Learning, adds the perspective that the use *of M-learning fits the Flipped Classroom, not only because content can be accessed anywhere the student may be, but also since it is addresses students' different learning styles (visual, audio,) and allows personalized self-paced learning".* (Moura, A, interview)

Many unique Applications of the Flipped Classroom

In terms of application, the Flipped Classroom has infinite applications, since each individual teacher can choose which pedagogies for the in-class activities, and different digital technology and software for the pre-class preparation. Thomas Arnett explains "*The Flipped Classroom is an approach that can enable diff types of methodologies, but it's not a methodology in of itself".* (Arnett, Thomas, interview).

Four unique applications of University Instructors

Eric Mazur (and Dr. Mota) apply Peer Instruction, mixed with Team-Based Learning, Problem and Project-based Learning. He created his own social learning platform, first Learning Catalytics, (which now belongs to Pearson), to ask open ended questions for the in-class components, as well as Clickers. Recently, he created a new social learning platform called Perusall, which is more sophisticated in terms of engaging with the textbook, allowing students to highlight text, chat asynchronously for the out of class component. From the beginning, Mazur prefered assigning readings from the textbook to assigning video lectures, because he doesn't believe in video, as *"there is very little cognitive engagement",* since students were still lectures passively. (Mazur, E)

Duke faculty Dr Roberts and Dr. Sperber also apply Larry Michaelsen TBL model of Group- Team-Based Learning, with Problem-Based Learning, Project-based Learning, and Peer Instruction. Both Dr. Roberts and Dr. Sperber share with group 1 the goal of the Flipped Classroom, which is "*to move beyond knowledge acquisition, recall, and practice and feedback, using peers, practice, and mentorship using Larry Michaelsen TBL model of Group- Team-Based Learning*". (Sperber, M)

Both Group 1 and 2 share in common Collaborative learning pedagogies: Team-Based Learning and Project-Based learning, as well as some Peer Instruction for clarification of new concepts. Both Dr. Roberts and Dr. Sperber (and all interviewees) start their class with a question about the pre-class assignment. Peer instruction is also used, as students can often times better answer their classmate's questions than teachers. In addition, Dr. Sperber shares the same knowledge complex as Dr. Mazur, in that *faculty are often so advanced in their thinking of the content, they have trouble remembering to explain some of the fundamentals like a novice would. Therefore, it is important that the in-class experience builds in time for this type of discussion between students.* (Sperber, M, interview)

In addition, Dr. Roberts uses Dr. Mazur's Learning Catalytics Software, used to ask open ended questions to students for the in-class learning component, for Readiness Assurance. Both groups (1 and 2) apply innovative learning techniques such as Readiness Assurance, Retrieval Practise, and Collaborative learning strategies.

Nevertheless, there are always some differences. For example, Dr. Mazur prefers assigning readings from the textbook because: *"I don't believe in video, as there is very little cognitive engagement for the subject of Physics* (Mazur, E., interview) To check students covered the material before class, Dr. Mazur created his own software, for students to engage in retrieval practice in a low-stakes, formative assessment scenario. D. Mazur created his own Social learning platform, Perusal, for the assimilation component of learning before class. This platform enables students to engage with the text-highlights text, and becomes a chat for the asynchronous out of class learning component.

For the course content, Dr. Roberts choses to use Duke University's MOOCS where the content is taught in video lectures. In addition, he also uses Sakai, Blackboard LMS, and Mindtap. *"Sakai, Blackboard LMS- is the best option for Readiness*

Assurance- Individual quizzes to team quizzes". (Roberts, C, interview) Like Mazur, Roberts (and Sperber) is also an advocate of Retreaval Practise, which is a learning theory that claims" taking Quizzes actually help students learn. *"Studies show it actually helps to learn, in the spacing between assessment and retrieval"* (Roberts, C, interview).

Dr. Roberts believes that the value of the flip lies is in the structure and intention of the class preparation versus the creation of lecture videos, and that is where he invests his time. Roberts believes: *"Structuring the pre-class material is essential. For example, asking students just to read chapter six because there is a quiz on Monday is not an effecting scaffolding. Rather, the instructor should tell the students the things to be learned for Monday, for example. The idea is to turn the learning objectives into objectively quantifiable statements. Here is the material you can use to prepare yourself for that. Thus, the instructor must make it clear to students that the pre-class information was required knowledge to solve problems. (*Roberts, C, interview)

In addition, Roberts applies the Backwards or Reverse Course Design, in which *"the first step is for the instructor to decide what mastery looks like in this topic, decide where the students are at the moment, and then work backwards progressively towards the objective. The whole reason of covering these concepts outside of class is because students need it to solve the problems in class.*" (Roberts, C). The whole idea is that *"Concepts need to be understood before students are able to solve problems"* (Roberts, C, interview).

For ESL and Linguistics professor Dr. Marshall, as long the information transfer happens outside of the class and the application of Flipped Learning can be applied in all sorts of situations, whether class is held face to face, or synchronously online. In all her classes, uses pedagogies such as Project-based Learning, Discover-Flip-Apply, Peer Instruction, PBL, her own MALP and Creative Fertile Spaces.

In addition, Dr. Marshall has a very unique application called the Online Flip, in which she provides videos for students to watch at home, and then meets students synchronously online via Adobe Connect, without ever meeting face-to-face. Although many people think that online learning is not as effective, Marshall assures there is no difference between her blended learning classes, where she meets her students face-to-face every week, and the classes she meets via Adobe Connect, a versatile software that provided her a platform for both the delivery of content and the synchronous sessions that Dr. Marshall incorporates in her flipped online delivery modalities. During the synchronous meeting sessions, students would log in and complete a "sign in" activity, based on the material from the lecture, which also served as a record of attendance. One of the aspects she likes the most is it is just like having a face-to-face class, where students break into groups, to work on activities in their own digital breakout rooms. Each group also has its own online collaborative whiteboard, and its own chat functionality. Everyone returns to a main meeting room to work together afterwards. Dr. Marshall emphasizes that there is no difference to her between her face to face class and her synchronous Online Flipped Class, because she can can 'roam' for room to room and observe or participate virtually and physically. *(Walsh, K, 2014)*

"This is how I teach my class- So the students all have webcams, audio, and a chat, and there is a list of attendees. I can do everything from my computer, everything I can do in a classroom, there is just no physical contact. I can conduct quizzes, use a whiteboard, I have all different layouts- discussion, a poll, I can create breakout rooms, it's a room just like any other room. I can send them into breakout rooms- which are

separate rooms- the different rooms can't hear each other. (Marshal, H) Dr. Marshall emphasizes that there is nothing innovative to this flipped class, except that it is held online instead of in person. "*The point is this is not innovative, all I am doing is the same as a regular class, except I'm doing it online. My students meet me and interact with me the same hours or even more online than face to face."*

In terms of pedagogies, Dr. Marshall also applies Dr. Ramsey Mussallam's Discover-Flip-Apply method, to peaks students´ interest and get them curious about the content that will studied at home. Then they are assigned a chapter, and then in class they start with the practice activities, that were assigned. She then has students complete practice activities for homework, and then they share in class. But the heart is that they do the activities together in class. Later on, they will get a quiz and a final.

The lecture is on the video, and they get scores- they get scores. Dr. Marshall creates Just-in Time quizzes, embedded in the video, which students must answer as they go. The results are graded using Zaption.com, where students get immediate feedback as they answer- in real time. The quizz is embeded in the the video, and Marshall just types in the feedback for each answer beforehand. (adapted from Marshall, H, interview)

Computer Science professor Dr. Ken Bauer, also shares the same Flipped Learning Network definition, but his application varies according to his own unique teaching style- including Discover, Flip, Apply, Student Exploration, Peer Based Learning, Project-based learning, Mastery Learning, Problem-Based Learning. Just like Dr. Bennet, Dr. Bauer is avid about teaching transversal values, and the value of relying on different sources of information. On a typical class *"I take up the first five minutes of class for general questions and doubts about the content. Then, I go around the class, helping students one-on-one or in groups. From there, I organizes them in groups and give feedback. I am flexible in that I let students choose to work on their own or collaboratively".*

In terms of social media, he is quite unique in that he uses Twitter, Facebook Groups, and blogs. Dr. Bauer uses Twitter to communicate, with a hashtag for the course- tags usernames. In addition, Twitter allows students to answer questions too, even for old students. "*I use a lot of Twitter to get a pulse of what's going on outside of class in terms of questions and doubts*". Bauer stopped using Forums on LMS (Blackboard, Moodle), and now prefers using Facebook private groups, "*because it tells you who has seen posts, as well as more personable blog posts for homework assignments".* (Bauer, K) In addition he also uses Socrative and Kahoot for quizzes.

High School Instructors Flipped Classroom Applications

High school Chemistry teacher Dr. Bennet, also applies Reverse Course Design (UDL) to plan his classes. Dr. Bennet, teaches high school Physics using UDL Inquiry, Project based learning, and Modelling instruction. What he appreciates most in his face-to -face classes is the increased interaction with his students, and opportunities for feedback in class.

" I encourage students to work at their own pace, and every time they need to check the content, instead of asking the teacher, they can just pull up the video and they don't have to wait for everybody to be done. The Modelling instruction is all based on the experience first, rather than replicating something they've already been told." (Bennet, B, interview)

Dr. Bennet doesn't rely on just one mode of instruction. *"(....) from my perspective the video is just another resource that I'm creating for my students. I have students that don't read the textbook, but I've got other ways for them to get that information and vice versa, I've got students that don't watch videos, but they read the textbook or they're doing the case study, or they're listening to me, or they're working with a group. I think reliance on any single mode of instruction, whether it's a video, or a book, or a* worksheet (…) *boxes you in and it doesn't allow the students multiple methods to be successful.*

According to UDL philosophy, the instructor must provide students with a variety of mediums from which students can choose to study the material, according to their particular learning strengths. *" Pamela Joseph, she's a researcher, she wrote about, she writes about curriculum and design of curriculum, and what she's found is that students, especially students who struggle in particular content area need multiple avenues for success to maintain their motivation and their drive to succeed. " (Bennet, B, interview)*

Other members of the FLN (Group 3- including Dr. Marshall, and Dr. Bauer) also share this same perspective.

With Regard to Reverse Course Design, he bases his planning on Wiggins and McTighe's theory, in which "*you have to know what your end task is and know everything leading up to that task accomplishes something to help the student be successful in the end*." (Bennet, B, interview) . For every chapter, Dr. Bennet creates a list of objectives, and useful vocabulary, that works like a tracker for their work.

"*So the objective is what they actually need to demonstrate to me. The objectives are tied to essential questions, which are tied to the big ideas, which are tied to the state standards. So I've kind of taken the state directions and split it down into something that's a little bit more understandable by students. And we do that on a chapter by chapter. So the beginning of each chapter I give them what I call a cover sheet, and it's got the objectives and the standards, and all those things on there. (...) So it's not, it's not just a list of tasks, it's all tied back to understanding. And my little gut check is if they can answer an essential question, they've earned their objectives and their meeting standards for the state."* (Bennet, B)

One of the main benefits of using the mastery pedagogy is that it allows more flexibility of time, for the students to work at their own pace. *"So that's where the flexibility comes in. The objectives need to be met by the end of the semester".* (Bennet, B)

Dr. Adelina Moura, a French and Portuguese high school teacher with a Masters in M-Learning, applies a range of active-learning, Project-Based learning, Collaborative Learning, Gamification, Peer-Based Learning, Clickers. The pedagogies she uses vary according to the content- she is not attached to any particular pedagogy or concept. Different methodologies work well with some classes and not at all with other.

For example, students who have seen the videos immediately can start the in-class exercises, and students who have not done the pre-class work, go to a corner of the room to view the videos, before they can begin the exercises. When she teaches a new subject/topic –she always tries to use the multimedia animations, to display the content. She creates Just-in-Time exercises, questions with immediate response- which students use the mobile devices to respond.

For Collaborative learning, she prefers putting student in pairs. She finds pairs work best (vs larger groups) because it is quicker and doesn't disturb the layout of the classroom. Students always know where to find the class content- in her class blog and where students find indications in advance on what is to bring to class. She also communicates with her class via email. For her lessons, she prefers the use of M-learning, as it is

quicker and more practical. For her French literature classes Dr. Moura also created a unique application, in which she records herself reading sections to read from the books in audio podcasts for her students to prepare their reading and pronunciation at home. Since the concepts can be practiced more than once, the material is more assimilated and therefore the test results are visible. (Moura, A)

Dr. Idalina Santos, Dr. Adelina Moura and Dr. Brian Bennet have unique applications of t he Flipped Classroom to their teach high school students. Idalina Santos and Moura prefer the use of the blog and the use of apps in gamification in the classroom, as they find it is more motivating and engaging for teenagers. Bennet, applies more of a flexible self-paced environment with Mastery Learning, in which students have until the end of the semester to proof their understanding.

Dr. Idalina Sousa, Portuguse High school Math teacher, and educational researcher, and Dr. Adelina Moura, aren't fixed to any particular pedagogies in class either. For example, Dr. Idalina Santos uses Peer Instruction and clickers to clarify misunderstandings students may have at the beginning of class, and then uses Gamification, using apps such as Kahoot and GoSoapbox for class games. She also encourages BYOD, bring your own device for in class activities. (Dr. Idalina Santos)

I prefer the use of apps because they still foster more their interest in participating in the classroom. (…) The use of apps (which may include games) in the classroom actually increase student motivation and involvement ... even the weaker students study at home to be able to participate in activities with apps. (Sousa, Idalina)

Nevertheless they have in common the variety of materials for course content.

But, other materials may be used, such as worksheets, the activity book, the student book, etc. This methodology is well suited for both pair work and/or group work or project- and always using active learning. I use videos, notes from websites, different presentations and even textbook pages, if necessary. These are very important for the purpose of acquiring basic knowledge at home. (Sousa, Idalina)

In terms of digital tools, D. Adelina Moura creates her own video tutorials using Educreations, and Showme, which are like an interactive whiteboard, where she makes diagrams, tables, of tutorials, and explanations. Most students view videos on their home computers, but some use tablets or mobile phones, as a more practical, comfortable way to view the information.

In her lessons, students are free to use tablets, and smartphones, where at any time they can review the videos, and don't need to call her unless they have any specific doubts.

	Dr. Mazur, Dr. Mota	Dr.Sperber Dr.Roberts	Dr.Marshal	Bauer	Moura, A	Sousa,
Digital Tools	Learning Catalytics Socrative Perussal	Sakai, Blackboard LMS, and Mindtap.	Adobe Connect Zaption Powwow	Twitter Facebook Groups Kahoot Socrative Blogs	Blog Podcast Educreations Showme Interactive Whiteboard	Kahoot Gosoapbox

Finally, educational researcher, Dr. Thomas Arnett, offers a more bird eye perspective of different flipped classrooms around the US. Arnett does not generalize in which regions the Flipped Classroom is more applied geographically. According to Arnett, rather than geographic location, the stronger predictor for the implementation of the Flipped Classroom depends on the specific circumstances that school leaders find themselves in, that determines the models they use. "*For example, if a director wants to incorporate technology and improve instruction in traditional classrooms, then they might choose a sustaining (educational) innovation (such as the Flipped Classroom, where students have individualized learning when they are watching videos, but the pace of the class is still moving collectively. For example, all students are working on unit 1, before they go to Unit 2. The specific pedagogies used depends on the particular needs and context of the teacher and the students. It's possible to mix different models for different activities and purposes."* (Arnett, T)

4.6.2. Varying Assessment Styles

With regard to the Assessment, like the applications, there are varying ways of assessment, which generally varies based on the type of pedagogy used. For example, instructors using Team-based learning, Problem-based Learning and Project-based learning are more likely to use specific assessments for those projects. Also Readiness Assurance is also a form of Continuous formative assessment used by instructors of those pedagogies (Dr. Mazur, Mota, Roberts, and Sperber.

Some instructors choose more traditional forms of assessment (Marshall, Moura, Sousa), other follow more innovative and flexible forms of assessment, (Bauer, Bennet,), and other, follow already established collaborative assessment strategies tied to specific pedagogies such as TBL (Roberts, Sperber, Mazur, Mota), and Mastery (Bauer, Bennet). There is no right or wrong way of evaluation. Regardless of what style of assessment is chosen, this aspect is fundamental to creating student accountability, and motivation for the Flipped Classroom to work.

First of all, all instructors start class with a low stakes assessment, to show student accountability for doing the pre-class work. From then on, the differences start.

Dr. Marshall claims that the most traditional part of her teaching is the Assessment. She claims to be innovative about her instruction, but not about her assessment (Marshall, H) I'm very "disruptive" in my teaching style and pedagogies, but the truth is my Assessment is quite traditional. She uses Ongoing, Formative, Collaborative, and Summative assessment (final grade is a sum of the total points).

Dr Santos and D. Moura also use a more classical form of assessment, enriched by the use of apps and Learning Analytics. "*The use of apps in class activities facilitates access to student responses, since there is an immediate record of assessment. The Flipped classroom allows the teacher to keep greater track of student records, which facilitates the continuous evaluation.* (Santos, I)

On the other end of the spectrum, are Dr. Bennet and Dr. Bauer, who use more flexible and innovative forms of Assessment, usually tied to Mastery learning. Dr. Bauer is very innovative in his Assessment: He gives two types of homework:

1. Connected MOOCs, where students must write weekly blog posts,

I assign a series of activities, with a linear progression of difficulty, where students do a connected Mooc style homework assignments. Students don't hand them to me but they post them as weekly blog posts.(Bauer, K)

2. A parallel list of 30 Mastery topics that student must prove they understand.

Then he has continuous assessment, on Socrative and Kahoot for ongoing quizzes, and then midterm and finals (as summative Assessment)

Students have to show they have mastered/ understand a selection of those topics, -graded Done or Not Done. Others are OSU- Outstanding, S-Satisfactory, U- Unsatisfactory, (graded in scales 2-1-0)

For one point, they must how they understand the concept (poem, song, video, etc.
For two point, they go deeper and create a resource that helps others to learn. Students choose how many points they want to do. There is a list of 30 topics- to get full marks they need to get 40 points. Students choose what they do to get 1, 2, or 3 points- to get the full mark at the end. They have the variable of choice on how many points they want to earn, based on how they prove their learning. This flexibility freaks a lot of students out. (Bauer, K)

Dr. Bennet also applies Mastery learning, where A*ssessment is constant ongoing in my class, it's very fluid*. He only has midterms and finals because they are state requirements. *For the summative aspect of it, I still do give tests, I still give multiple choice paper and pencil tests, (Bennet, B)*

With Mastery learning, ongoing assessment is more flexible, since students have until the end of the semester to prove their understanding of particular concepts.

"I schedule for example three weeks for the last unit. So in those three weeks they needed to achieve those three objectives. If at the end of the unit, at the end of the test, they still haven't shown, so if the student still could not explain those methods of heat transfer; conduction, convection. In the grade book I do put in a failing mark, but I can go back at any point and change that mark up until the end of the semester. (Bennet, B)

Another interesting aspect is Dr. Bennet gives students freedom to demonstrate their understanding in any form they want. "*Once they have understood a concept, "they can show me any way they want. They can do that on a quiz or test, discussion, they can create a poster, they can make a video, you know, whatever, as long as they show me that they know what they're talking about so that I can report back and say, yes my students have achieved this standard, I'm good. (Bennet)*

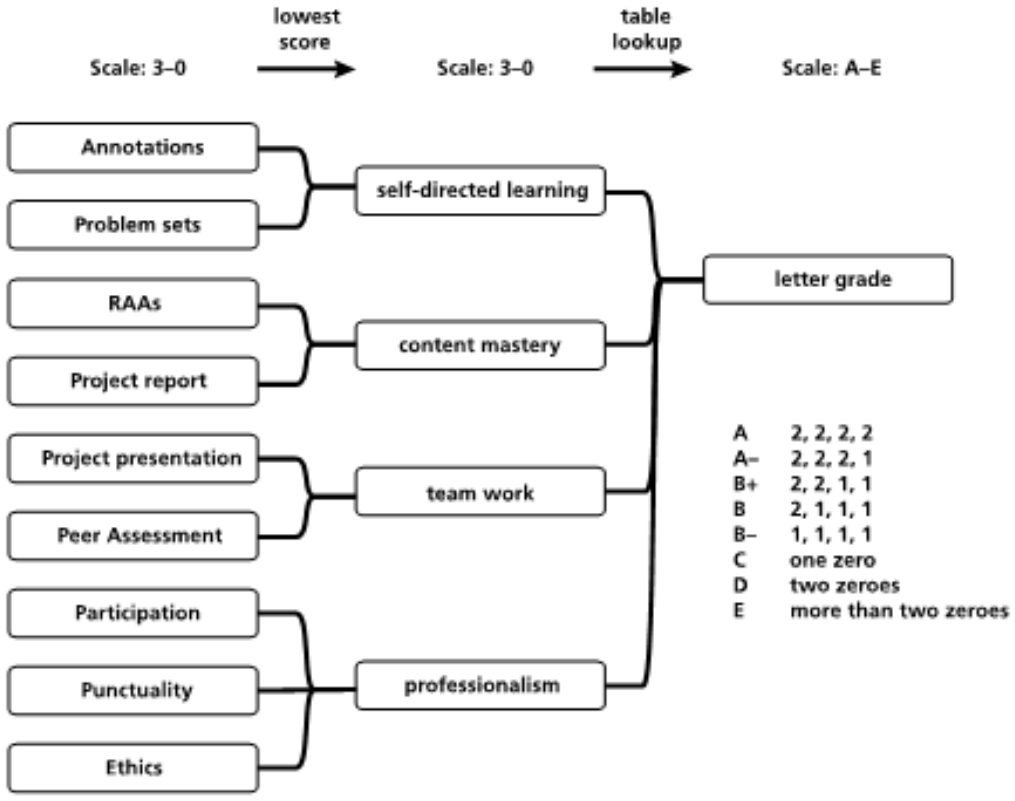
For all the instructors that apply TBL (Team-based Learning)*: Dr. Mazur, Dr. Mota, Dr. Roberts and Dr. Sperber),* students are evaluated in a *mix of individual and group work assessment TBL, assessment is also made by the peers. (Mota, A)* Also Readiness Assurance is also a form of Continuous formative assessment used by instructors of those pedagogies to check students understanding of material.

Dr. Roberts and Sperber are experts in Group and Team-based Learning, use a mix of Group- Team-Based Learning : Mix of Red, Cooperative Learning, Peer Instruction, PBL, Research, Retreaval Practise. The Group assessment is fundamental component, as in "in group projects, there is no way to recognize the students who participate."

Dr. Sperber defends the need for a mix of individual and group assessment: *"To me, a good flipped classroom contains always contains formative assessment, discussion and debate between students, feedback and targeted instruction on the trouble spots, and real-world problem solving."* (Sperber, M) "*TBL approach to formative assessment, an individual followed by a team assessment – using the same questions for both assessments. Individually, students are held accountable for preparing for class. As a team, they learn from one another, as they debate which multiple-choice answers to select. By the time this process is done, students are ready to move to the higher levels of learning, by applying their knowledge. " (Sperber, M)*

In addition, Dr. Roberts explains that in TBL, collaboration and participation is a key element of evaluation. Research says that in general, teams score higher *than the smartest person in the team.* That is why teams are defined during the 1st week of class, and they must have *the same partners throughout the semester*. This also helps develop stronger relations and pushes students to work through inner disputes, which ultimately is a valuable life skill. (Robert, C)

Dr. Ana Rita Mota explains the assessment process for TBL for Dr. Mazur's Physics classes, where students are constantly being evaluated in different tasks and skills. "*In a semester students complete more than 50 assignments!). (*Mota, A) TBL is very complex and unique to each class. The following diagram, provided by Dr. Mota, describes the Assessment process in Dr. Mazur's AP50 Physics class:



(Mazur, 2015)

4.6.3. The Possibilities of implementing Flipped Classroom

Regarding the interviewees' perspectives on the Advantages of implementing the Flipped Classroom, the results were overwhelmingly positive. Responses concluded that the Flipped Classroom increased the learning results, increased the student's autonomy and responsibility, active learning pedagogies increased student engagement, strengthened team-building skills, and even strengthened student teacher interaction.

The first noticeable advantage felt was an increase in student learning. Dr. Mazur says his students *"doubled the learning gain and two or three years later, tripled the learning gain by asking better questions in class".* (Mazur, E) Dr. Ana Rita Mota pointed out that students are able to be involved cognitively in classes because they have some base knowledge when they enter the class. Dr. Moura also mentioned that watching the videos at home, allows students to anticipate the contents of the lesson at home before class. (Moura)

Dr. Marshall found that students actually increase their comprehension of the material, when they could watch and repeat the videos as many times as needed. (Marshall) In addition, students can get more practise use class time for discussions, projects, and other class activities. (Marshall).

Dr. Bauer appreciates that when students learn by themselves, they can become better students in the long run. (Bauer, K). Dr. Moura noticed also increased student learning, especially for the motivated students. She claims that since exercises can be practiced more than once, the material is more assimilated more and therefore the test results are visible (Moura). Tied to increase in learning, is the deeper learning When the basic level of content understanding is covered in Bloom's Learning Taxonomy, students can reach higher levels of understanding, such as critical thinking. Dr. Roberts mentioned that in the flipped classroom, *students can work beyond the basic understanding of content compared to a traditional classroom* (Roberts, C). D. Marshall and Dr. Sperber emphasize also an increase in student Critical thinking skills and problem-solving skills in class. (Sperber, Marshall)

Dr. Moura *she felt an improvement, in students test results*, especially for the motivated students. She felt the most increase in the average students, *"who increased from C to B. For failing students, there was a slight improvement." With the FC, exercises concepts can be practiced more than once, the material is more assimilated more and therefore the test results are visible.* (Adelina Moura)

What enables students to reach higher levels of learning, is the better use of class time, the increases of value of education, and in many cases, increase of student satisfaction. Since education is very expensive (especially in the US), and if students can find good lectures online, then why are they paying for education? Dr. Roberts, explains *" If it's just thelLectures, and they can also be found online, then that dilutes the value of in-person higher education.* Therefore, *"The biggest advantage of the Flipped Classroom is it maximizes the efficiency of use of class time. (...) because it highlights the advantages of synchronous, face to face instruction/education. (...) Students feel like their use of time is well spent in class, and thus it increases the value of education.* (Roberts, C)

Moreover, putting the responsibility of the learning on the students gives them a sense of autonomy and increases student engagement. Dr. Mota says students to take responsibility for their own learning (Mota) D. Idalina Santos says the Flipped Classroom is a great way to motivate students' learning, and it promotes more responsible and autonomous students (Santos, I)

D. Marshall explains that when you put the responsibility of learning on the students, it changes the question from *: Did you get it* to *Do I get it*? It gives the control of the class to the students, who are now active and engaged (Marshall, H) Dr. Sperber also advocates that t*he flipped classroom is a step in the right direction, to putting students in the position where they have to become more responsible for their learning,* (Sperber)

M-learning specialist Dr. Moura mentions that when students enjoy managing their own learning, because it *"allows more flexibility of time and location"* (Moura) She explains *"The concept of Flipped Classroom helps enhance these opportunities and helps the student to self-organize themselves, make a study self-directed, custom, (students can watch and repeat videos as needed.* (Moura, A)

High school instructors Dr. Moura and D. Bennet also mention the added benefit for students with different learning styles and disabilities. *In addition, to encouraging autonomous active learning, and helps students in their learning styles (i.e) a few more visual, more impaired, etc). Students enjoy, see the benefits, and ask for more* (Moura, A) Dr Bennet, who applies Mastery Learning pedagogy in his flipped classroom also appreciates more flexibility of time, for the students to work at their own pace. He also notices students develop more quickly as independent learners. *They have a better understanding of what learning actually looks like, because it's not wrapped up in the school structures. I think it also empowers them to make decisions about how they learn.* (Bennett, B)

Collaborative work works very well in the Flipped Classroom because it strengthens student's team-based Skills. Dr. Mota observed that *students learn better with each other than with teachers, because they can be cognitively more active in pair discussion".* Dr. Sperber adds that the Flipped Classrooms gives student the opportunity *to teach their peers, provide and receive performance feedback from peers, defend what they think is correct based on what they have learned, and make decisions that professionals in the field have to make* (Sperber, M) Dr. Santos adds the *it's the best way of being in the classroom and in group work, less indiscipline and much more student involvement. (Santos, I)*

On the contrary to what many think that digital technologies make students and teachers more distant, Dr. Bauer and Dr. Marshall claims, the Flipped Classroom actually increases interaction with instructor and peers. *It enables the instructor to provide more personalized student guidance and more teacher- student interaction.* (Marshall, H) On the biggest benefits for Dr. Bauer is it *"allows instructors to spend more time on what is important.(Teacher-Student interaction and Feedback*) *Students liked more time actually with the teacher- gained confidence in talking with the teacher.* (Bauer, K) D. Santos also points out that since the Lessons are less expository, this enables the teacher to follow students more closely. (Santos, I)

In addition, because the preparation is mostly done at the beginning of the semester, *the teacher has a clearer head of what he must do., so he/she can focus all the energy to be present in class- for feedback and guidance. (Bauer)* Dr. Santos enjoys the benefit that teachers can individualize the support students need, (Santos, I)

Other benefits of applying the Flipped Classroom to schools include helps students gain valuable XXI century skills, and at the same time helping schools need to catch on to technological integration (Marshall, H) . Also, Dr. Santos mentions an

important benefit of the Flipped Classroom, which it helps minimize extensive curricular programs imposed on the teachers (Santos, I)

From the perspective of a educational researcher, this model is relatively easy to implement, when compared to other B-Learning models). *Generally, the Flipped Classroom model is relatively easy for teachers to implement on their own, compared to other models, which involve staff and faculty collaboration. The Flipped Classroom, being a Sustaining innovation, makes improvements on the traditional instruction, building upon what the school is already doing, and making improvements from there. (Arnett)* However, from an instructor's perspective, who have put lots of time and resources into the implementing the Flipped Classroom, may disagree with this perspective.

All benefits mentioned corresponded to the those mentioned in the Literature review.

4.6.4. Limitations of implementing the Flipped Classroom

The number one problem all instructors faced was **getting students to do the pre-class work.** The element of execution of the Flipped Classroom should be carefully thoughtout and planned- in terms of content and assessment.
A common criticism of the Flipped Model is how do you know if the students are really watching the videos?That is an element of execution. It's a matter or software, or learning culture (around students and families) . (Arnett, T)

The main obstacle D. Mazur faced was *how to engage the students in a meaningful way with the material before class*. I tried video, but students learned too passively). *The textbook required an extrinsic factor. Just in time teaching- works well, but is a lot of work (Mazur, E)* Dr. Mazur first struggled with the problem of accountability, on how to get the students to do the pre-class work. *That is why the teacher must create mechanisms to ensure that the student has been prepared at home* (Mota, A)

In addition, *the instructor must develop material that fits and complements this methodology.* To tackle this issue, D. Mazur came up with the solution of creating his own software, Perussal for students to engage in retrieval practice in a low-stakes, formative assessment.

Dr. Roberts found that cooperative learning helps a lot in the accountability issue. *"You have to make it clear that students have to participate, and not let their team down, because its directly correlated to their final grade."* (Roberts, C)
Dr. Sperber also defends *"this is best accomplished by starting class sessions with a low-stakes assessment. It doesn't have to count for much, but it has to count."*

The Flipped Classroom doesn't always change unmotivated students

D. Moura shares a similar concern that not all of her high school students watched the videos at home. *The technology makes it easier, but it does not solve all the problems of unmotivated students. It is not because tey have the technology that they suddenly become intelligent and interested. There is a bit of excitement in the beginning, but the students who don't want anything to do with the school, nor with the technology. (Moura, A)*

Another important point is *The technology only works to the extent that the student make use of them. If the student chooses to use the technology, at home, he/she can repeat as many times as you needed (Moura, A)*

D. Marshall, also laments that there is always a minority of students who are not motivated and don't watch the videos, and therefore can't do anything in class. In some cases, she has had hesitant students who don't want to watch videos because they prefer to learn directly from the teacher and can't change their mentality. (Marshall, H) D. Ken Bauer also shares this same experience. *"Some students are really good at playing the "school game". It's very scary for some students to have to be responsible for their learning."*(Bauer, K)

Therefore, it is crucial for instructors to build accountability for students (and teacher). This might involve either students doing a quiz on the video (Just-in-Time), or have them answering questions before class, or have a question as a "password" to participate in class.

Dr. Roberts believes that intentional and well planned- out content is essential to motivate students. "*You have to be intentional about your content, communicate that clearly, and there has to be connection between the pre-class work and the in class you want them to be prepared for. If the material isn't linked, students will catch on. But if you are just putting up videos online and the material isn't linked, and then you do exercises in class, students can detect this." If you are just putting videos online and then giving them problems in class, and then you don't communicate openly why you're doing this, you will get disengagement. Then they think they are doing all the work, so you can have more free time* (Roberts, C)

D. Bennet struggles with the fact that giving students more flexibility and responsibility can be challenging for unmotivated students. "*It's hard for students to become responsible for their learning, and to understand that it's their job to learn. They understand that it's their job to do worksheets and to be attentive. But they don't know what learning looks like and the struggle that has to happen. And so when they get frustrated, and they feel like they're struggling, they tend to shut down, rather than persevere." (*Bennet, B)

However, Bennet sees this difficulty as his main mission as his new position as a guide. *"My job is in the classrooms, is to help them bridge that gap- to help students use the confusion they feel to drive understanding in the long run."* (Bennet, B)

Even though it might seem that all the work is for the students, in reality, the Flipped Classroom implies **more work for the teacher**. In fact, Dr. Sperber defends *"Instructors are not being lazy, in fact their workload can at least triple when they decide to flip a course like this" They spend a significant amount of time prior to the start of the semester redesigning their course"* (Sperber, M)

Dr Bauer is very active in his class, and is constantly going around the room, and it's also *"very tiring*". (Bauer, K). However, he resists the definition of more work, he is prefers " spending more time on what is important. In other words, instead of spending his time correcting quizzes, he would much rather spend more time doing activities with the students, and increasing student-teacher interaction and feedback. Moreover, his classes are never a dull or repetitive, even if the same material is being taught. (Bauer, K)

Without a doubt, "*it's more work for the teacher, both in preparing material and in the implementation of the material." (...) it puts a lot more pressure on me to be lucid in the classroom at all times. They're very few days where I can just sit down…"* (Bennet, B)
Dr. Mota also points out the planning and assessment processes *in particular is a lot of work...for the teacher. (Mota, A)*

It**'s impossible to implement the Flipped Classroom without support**, because it requires a lot of commitment and institutional support.

Dr. Bauer emphasizes the cooperative effort that Flipping requires. *"Teachers, students, and the administration must all buy in."* (Bauer, K)
"It is impossible to do this without support of the school administration".
In his case, the Tecnico de Monterrey- gives flexibility. However, initially, administrators were not used to flipping control and many teachers as well. *Initially, I got one bad teaching evaluation- because students didn't like it, and the boss was afraid of losing students.*

I am not afraid, or resistant to change, because there are many teachers who scared of changing, for fear of administration or student push back."

Bauer emphasizes the need for institutions to get *"closer to getting more flexibility in and out of the classroom"*. (Bauer, K) Originally, he was the only teacher but now there are a lot of people flipping he didn't know about. He has spent last three years giving teacher training that is open for everyone.

Dr. Sperber, defends that *faculty have a much higher chance of success when flipping a classroom if they have support from an experienced instructional designer and a network of peers with whom they could share experiences.* (Sperber, M)

Another factor is that it's **difficult to flip for the first time**. Teachers (and students) must be willing to experiment with alternative strategies.

Change does not come easily. According to Dr. Bauer, "*It takes time for students and faculty to get rid of the lecture-based traditional classroom format"* (Bauer, K) The reality is the Flipped the Classroom demands a steep learning curve for the teachers, *it is not an quick and immediate change, it requires research, training, discussion,* says D. Sperber. *This model requires especially the motivation of the teacher to learn the technologies, and the willingness to risk trying new pedagogies, and not stay tied to the traditional classroom.* (Moura, A)

In addition, it is important for the teacher to feel confident with your material and students, to be able to make changes. *"It's hard to do any innovation if you are not confident with the material you are teaching. It depends on your style, your relationship of your students, school, etc."*(Bauer, K)

Access to internet may vary, both for students and schools (and even classrooms). Firstly, there might be limited internet access at school. *Too much dependence on technologies can bring problems when there is a failure. When they are too many devices connected to wireless (in the classroom), the internet is slow- and the connection can fail.* (Moura, A)

To D. Idalina Santos, "*The biggest problem/difficulty is access to the Internet at school. Sometimes the activities take a little longer to start due to technical problems*. However, in her experience, this problem of Internet access at school (signal strength) can be easily resolved *by changing rooms or even by moving to the library…* (Santos, I)

Also, it is important to note that both D.Santos and D. Moura both apply Gamification pedagogy in class, which is dependent on internet access. This can be easily changed by doing activities in class that don't require a lot of technology.

Then there is the issue of limited internet access at home, which can be solved by providing the material on a pen, or even a dvd. *For everyone to have equal access to materials, it is necessary to know who has access to the Internet at home in order to save the materials on a pen drive for students who do not have internet access at home*. (Sousa, Idalina)

Finally, the reality is the Flipped Classroom is not for everyone.

Students are different, the technologies and the pedagogy is the same- The same pedagogies may work well with some students, and not so well with others (Moura, Adelina)

That is why it is important to make an educated, well planned out decision to flip. The Flipped Classroom is just one model, among many Blended Learning models. Educational researcher Dr. Thomas Arnett strongly advises schools and teachers to *"test*

your assumptions on the execution" before investing all their resources on the Flipped Classroom.

Before embarking on choosing the Flipped classroom model, first ask yourself: What goal do you want to accomplish? 1) Do you want to improving student outcomes (tests), 2) increase student engagement 3) or improve student access to education opportunities? (Arnett, T)

Instructors should try out quick and easy pilot experiments of the Flipped Classroom, before implementing the Flipped Classroom model immediately. *The Discovery and Planning Process can save time and resources instead of diving direct to a new model.*

Ex) Try out a few lessons with the Flipped Classroom model, or for a few students, for supplemental activities- before moving all your resources and time into implementing the model in your course or institution. (Arnett, T)

All points mentioned above match up with the literature review that describe the Disadvantages of implementing the Flipped Classroom,

4.6.5. Future Directions: The Flipped Classroom is here to stay

In terms of Future Directions of the Flipped Classroom, overwhelmingly all interviewees claim that it is here to stay. As it i*ncreasingly has more enthusiasts and that significantly will alter the way teachers teach.* Santos even mentioned that with the strategies of evaluation will also change. (Santos, I).

Dr. Mazur s has seen the Flipped Classroom continuously spreading all over the world. *"North, South America, UK, France, Holland, and Asia,* are the locations where "*it's picking up quite fast.* It has also started growing in countries *Chile, Peru, Ecuador, Peru, Central am- Costa Rica, Guatemala, Panama.* (Mazur, E) Interestingly, in the rest of Europe the the Flipped Classroom has been slower to catch on. Mazur attributes that to its *long tradition in education (Bologna)- still teaching the same they were 1000 years ago* (Mazur, E)

Portuguese high school teacher D. Moura says *"The future directions of the Flipped Classroom depend on the willingness of teachers to apply it. In Portugal, the path is long, there aren't that many teachers, peers who use the technologies in the classroom. Teachers who use these methodologies are few in relation to the total.* She also points out to the need for Institutions, and individuals to invest in teacher training, *to facilitate the transition* (Moura, A)

Educational researcher Dr Arnett reassures that *"Generally over time B-learning will become more mainstream"*. In addition, *"schools and teachers that will continue to use the model and it's easy to expect that that over time, the tools will continue to improve,* and that "*teachers and schools will continue to choose this model." (Arnett, T)*

Nevertheless, like D. Moura pointed out, the more "*teachers can show and prove that the Flipped Classroom is working to improve student outcomes, the more likely it will continue."* So the specific localities and regions where it grows more are *dependent a lot on the quality of the initial implementations that will demonstrate the results that others are attracted to*. (Arnett, T)

To D. Bennet, the Flipped Classroom is here to stay, because it's such a very approachable idea that teachers can apply, that *helps build out an effective learning program for my students*. (Bennet, B) Not only that, but it's an ongoing process, that promotes self-awareness of teachers and students, and lifelong learning. He compares it as *a new learning gateway,* because it helps teachers find more effective ways of teaching

the same material, so " *people understand that they can take what they're already doing well and expand on it in meaningful ways."* (Bennet, B)

D. Bauer also believes the Flipped Classroom is not a new fad. *"Humans have been learning like this this for thousands of years, by going out and finding out the information. Humans learning is a social process. What is new is Technology. We live in a time (XXI century) in which this kind of learning is simpler to do,* for example making *(videos and presentations)* (Bauer, K). Using technology for Flipping *helps learning to be more natural. Actually, the lecture model is relatively new (to the XIX, XX century), but learning is not.* (Bauer, K)

Dr. Marshall adds to that perspective by pointing out to the need of schools *"to catch on to technological integration and flip is an excellent way of dealing with that."* (Marshall, H) In addition, she also adds a future element, in which *"Flipping will become the default way of learning (...) The word Flip will go away and it will be synonymous of learning"*. *"The Flipped Classroom will become a Retronym, a name to what used to the be the norm, a concept that reflects changes in society.* She believes students will get the information from elsewhere and it will be the way education happens. (Marshall, H)

5. Conclusion

Today, the evolution of information and technological is developing the slowest in the education. To enter the Era of Information, it is increasingly necessary to educate citizens who can solve contextual problems. The Flipped Classroom is a teaching approach that arose in response to the increasing curricular school demands for teachers to teach the content to large groups of students with varying levels in a very limited amount of time. The Flipped Classroom, a form of B-learning, uses digital technology to facilitate student learning in the classroom, focusing above all on the student. However, is not a methodology, although teaching and learning methodologies can be applied. It is best to defined as a model or teaching approach.

As there are few rigorous studies on the flipped Classroom, it is difficult to quantify scientific data. There are many studies about the success of the theories of learning that can be used in the classroom (active learning, collaborative work, project work, just in time, teaching the pairs) However, despite the apparent lack of scientific evidence, all results of the schools where it is implemented with success has verified that the results are still to come, and the few schools that implement this model shows an increase of results in teachers grading and students' feedback.

Upon analysing the individual interviews of flipped classroom instructors around the world, professionals from different organizations also share common points regarding the implementation of the Flipped Classroom. The results included various definitions of the same Flipped Classroom, the variety of pedagogies that can applied in the classroom, varying according to teacher styles and student body. In addition, the advantages that outweighed the disadvantages of applying this model, including the increase of student learning results, the increased student engagement in class activities, that resulted from putting the responsibility of the learning on the students.

Although the flipped classroom is not a methodology, but rather a model, an approach, it ultimately frees up face to face classroom time where a variety of teaching methodologies and scientifically proven instruction pedagogies can be applied, such as active learning, collaborative work, work group project, troubleshooting, teaching the peer instruction, Just in Time). The efficiency of class time is key. It is up to the openness and creativity to choose what to do with this time made available.

There are also disadvantages in this model. There are people who claim the Flipped Classroom may be just another fashionable trend of web 2.0. What is worse is the student and faculty resistance to digital technologies. To work, there must be openness to the unknown, and willingness to take risks. Another obstacle is still the ongoing debate between pedagogues, which is the question of the importance of the acquisition of knowledge, versus the need for skills acquisition for the working place. The choice between one and another depends on the values and objectives of each family and school philosophy.

The most diverging perspectives came from the Application, in which each instructor had his own unique Application and Assessment. In general, all instructors shared similar perspectives with regards to the Advantages, Disadvantages, and Future Directions of the Flipped Classroom model. Overwhelmingly, all interviewees agree that the Flipped Classroom is not a passing fad, but is here to stay. It just depends on the open mindedness of instructors and institutions to try something new in their classroom.

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7 Interview Transcriptions

Interview Transcription Mr. Brian Bennet

START: 00:01:40

Brian: My name is Brian Bennet and I teach high school science, mainly chemistry, but I've taught biology and physics as well. And I was a new teacher in 2009. I was teaching chemistry and I got interested in flipped classrooms mainly because my students, my AP Chemistry students were struggling with their homework, pretty frequently. It was towards the end of the year, and we were working on free response questions, really in depth, you know, hard chemistry questions. And so I was looking for ways to help them with their homework, and I was on the college board here in the United States, ran an email discussion board, and so I sent some questions out, just generally to this email group looking for insight from other teachers, and John Bergman wrote me an email that said, why don't you make them a video. And I had no kind of understanding of what that meant. So we started up an email conversation, and I said, can you explain this to me, I don't know what you mean by make them a video. And so he kind of explained what he and Aaron Sams had been doing with their students and recording these simple videos for their students to watch. So I managed to get my hands on some hardware and software, and I started making answer key videos for my students for their homework that night. And it turned into a long-term relationship with these guys where I ended up going to a conference that they hosted at their school in Colorado. And the following year I had decided to flip everything, not just for my AP classes, but for my general chemistry classes as well. We did all of our instruction flipped to all of the assessment was flipped and that led me into things like mastery learning and standards based grading, and modeling instruction, and all these different methods that are much more student centered. But it really started with thinking through where my instruction was happening in the learning process.

Kristina: Exactly, and exactly. And so what were your results like your first time that you flipped?

Brian: Yeah, the homework, the homework videos were very, very popular, students loved having those, because I didn't post them immediately. I didn't post them ahead of time, it was after school, you know, a few hours after they had, had class, had a chance to work on things, and I would post the video. And so they liked having that time to kind of work on stuff, and then they would confirm what they had done, or they would find their mistakes and we could pick up there the next day in class. The year I fully flipped, the hardest thing for my students to understand was that they were responsible for staying on top of the work. And I had laid out schedules and set up programs for them to stay, to be successful with managing their time. But that was a big shift, because typically the teacher is the one who says, things are due on this day, and this test is on this day, and this is when you need to be able to do this, you know, x, y, or z. And as I went through that first year fully flipped it really turned into, you know, for instance I would come in on a Monday and say by Friday you have to be able to do these things. Some students would do it right away, other students would kind of fall in the middle of the group, and others would wait until the last minute. And I was working with them on managing how they use their class time, to try to teach them that getting early feedback is beneficial, it's more helpful than getting, even if it's wrong, you know, is more helpful than waiting until the very end and cramming for things like they're used to doing. I think if I were to generalize, so this is my seventh year teaching over the last six years of flipping, I would say in general, students towards the lower end, so F's, D's, and C's, typically jump a letter grade. So a D would become a C, a C would become a B. My A's though tend to struggle because they're used to working the school system, you know, doing homework and staying on top of the group, they weren't used to applying things, so they would most, a lot of them would actually slip into the B range before kind of regaining their feet and figuring out that they needed to think differently about how they approach learning.

Kristina: Yeah, and well I know I read it. How, what kind of assessment do, in this new shift like how do you assess like the students? And also how do you deal with students who don't watch the videos?

Brian: So assessment, I've learned a lot. I'm also in graduate school, and I went through a course on curriculum design and assessment, and how do we build out kind of a well rounded system, and I really keep coming back to the idea that assessment needs to inform not just me about where my students are, but also needs to inform my students about where they are. And that two way, you know, is the formative aspect. So I'm constantly asking questions, I'm constantly roaming around and looking at the work they're doing, and observing and reading, looking at when we do quizzes it's really just as a check in. Here's where you are, here's your diagnostic, and here's how you can fix that. So assessment is a constant ongoing thing in my class, so it's very fluid. For the summative aspect of it, I still do give tests, I still give multiple choice paper and pencil tests, but that's mainly to keep track of the standards that I'm assessing for my state requirements essentially. So here in the United States we have different state mandated standards that my students are responsible for, that I have to assess throughout the year. And that's what the paper and pencil tests allow me to do. Before we get into that tests, I already have a good idea where my students are and that's more just so I have an objective data set to submit to my administrators. But assessment is really woven into just about every single thing we do in the classroom now. Because it's really, it's the importance of getting information in, the input from students so that I can then turn it around and create something to help them continue to be successful.

Kristina: And like, how about the timing amongst like if each student is at a different pace, or at a different stage, how do you navigate the whole class the same like direction?

Brian: Yeah, yeah. I've done this two different ways. So there's one year where I was in a one to one situation, where all of my students had devices, they were little Netbooks, you know, kind of like the precursor to the Chromebook, just this little computer that they could use to do what they needed to do. And that system, it was very much, the major deadlines were, and this is at the end of the semester after they've had a long time working from day-to-day deadlines, or week-to-week deadlines. But the major deadlines were really just the pacing that needed to be set, you know, so they would have a week to complete a certain number of tasks, or to prove that they learned a certain number of things to me. And part of having those resources was that they could prove in whatever way they wanted. So I had students that would write, you know, they would write essays, they would do blog posts and reflections. I had other students that I would have discussions with. I had some who still preferred to take quizzes, because that was the only way they really knew how to assess themselves. So in that system it was, I just kind of had a menu, where they could say, I'm ready for this thing, and I would be able to give them that thing, whatever it was, it was very individualized. Currently, I'm in a school where we don't have those resources. So while day-to-day is a little bit open-ended, where some students are moving ahead, other students are getting a little bit more help from me. This past couple of years I've had to pace the class a little bit more synchronously, you know, for instance we'd all do a lab on the same day, we all take a quiz on the same day, just to maintain my own sanity in setting up or tearing down a lab, or to maintain the integrity of the assignment or assessment I was trying to run. So the personalization or that kind of self pacing happens more in the process, not so much in the assessment side of it right now.

Kristina: Can I ask you like how would you, like would a typical week look like, or a day let's say. What would a typical day look like for you like in a chemistry class like?

Brian: So if we're not doing a lab or we're not doing a quiz or something, you know, I think at this point in the year, a typical day, I'm still, I'm working in a school where about twenty percent of my students are without some kind of reliable technology access. So whether it's a computer at home, or smart phone. So a typical day would be my classes are about fifty minutes. So I'd come in, I'd have some reminders for them, general things, you know, test or quiz coming up or projects, you know, whatever, some big thing that the entire class needs to hear. I also have daily objectives. So we're always working off a central question or main idea within a chapter so that

they're focused on what they're doing. Sometimes that is they're continuing like a case study would be the best way to put it, where they have some reading, they might have some instruction that they have to get, they might have some notes that they're working from where they're analyzing information. And it's really a first pass, I need to see what they can do, so it's a lot of graphing, it's a lot of data interpretation and trying to put together ideas. For others, it might be small group instruction, where we're mediating a little bit, there might be people who have missed class, and still then their might be some who are reading the textbook or they're watching a video on their phone, catching up or moving ahead. So I do try to keep it open ended as much as I can, because I don't like standing up at the front of the room and talking. There are days when I do need to teach in front of the room, and even when I do that I try to make it more interactive by using clickers to give me feedback, or it's broken up into very small segments where I teach a portion and then they go do something with that, then they come back as a group and do the next piece and they do something with it. So even though I'm controlling the flow of the class, it's very teacher centered at some points, I still try and work in some of those student-centered techniques.

Kristina: Yeah, and about when like students don't watch a video, etc., etc.

Brian: Yeah, I guess kind of along those lines, from my perspective the video is just another resource that I'm creating for my students. I have students that don't read the textbook, but you know, I've got other ways for them to get that information and vice versa, I've got students that don't watch videos, but they read the textbook or they're doing the case study, or they're listening to me, or they're working with a group. I think reliance on any single mode of instruction, whether it's a video, or a book, or a worksheet or whatever, it boxes you in and it doesn't allow the students multiple methods to be successful. And that's actually something, there's I'm going to blank on the authors name, Joseph, Pamela Joseph, she's a researcher, she wrote about, she writes about curriculum and design of curriculum, and what she's found is that students, especially students who struggle in particular content area need multiple avenues for success to maintain their motivation and their drive to succeed. So in my classroom the video can be one modicum of success, you know, they can get their notes done on their own individually whenever they're ready for it and feel pride in getting that done, because it serves a purpose. At the same time, you know, they can do the same thing if their phone batteries dead, well there's another way to do that, they're not locked into this single method. And it also helps to build community, because students who don't have access to the Internet at school on a phone, or at home on a computer, you know, they can start to feel alienated if everyone's always got a phone out doing something. So I try and limit that by giving them multiple ways to get the same task done. And it allows them also to work in an environment that's conducive to their own learning. So there may be days when they want to work alone, and they put in headphones and listen to a video and do the worksheet or whatever. There might also be days where they work in a small group, and they can choose and they can make those decisions for themselves, which empowers them in the classroom.

Kristina: And you make that choice at the beginning of class, or is that all…?

Brian: It goes throughout, you know, it's very free flowing. So they may start in a group, and then they, one person might slowly realize they have no idea what's going on. Or I may help them understand that as I'm walking around and I see one person just kind of floating along. You know, I have those options in my tool belt then to say, here take out your phone and go take a look at this, and then come back to the group. Because you're not, it's not helping, you're only hurting yourself by kind of riding the wave, you know, I can have those layers of intervention that I can use when they're needed.

Kristina: Yeah. And so that plays into universal, UDL, right? Universal…

Brian: Absolutely.

Kristina: Developmental learning.

Brian: Yeah, definitely because I know what the end task is, you know. So Wiggins and McTighe, when they're talking about UDL, they're saying you have to know what your end task is and know everything leading up to that task accomplishes something to help the student be successful in the end. Yeah, and these tie into that exactly.

Kristina: So for you, you can have the video, you textbooks and other avenues.

Brian: Yeah, video, textbooks, sometimes it's just the Google search, you know, sometimes they may have recommended websites or articles. You know, it's really just taking the best of anything I, or other students, or other teachers have given me and using them to their strengths. And you know, there's obviously discretion involved, like when my students are learning how to do algebra, in the science classroom a video is more conducive perhaps than a textbook because they can listen and watch and hear me explaining, rather than just reading it on a paper. So there is still some discretion in which tool is used when. But, they are all available.

Kristina: I guess my biggest, my question is how, what is the guiding of, the guide, the main guide of like, is it, do you have a curriculum, do students have like the syllabus and the students are working down the syllabus?

Brian: No, I break each chapter out. So as I do use the textbook as kind of my main guide, but I mentioned the state standards, and if you'd like to see those so you know what they look like, I can send you a link to the Indiana state standards. So I use those standards, but then I distill it down into big ideas and essential questions. So the big ideas is kind of the, you know, umbrella for a particular chapter. Essential questions they target certain ideas within that umbrella. And then I take it one step further and I give my students objectives. So the objective is what they actually need to demonstrate to me. The objectives are tied to essential questions, which are tied to the big ideas, which are tied to the state standards. So I've kind of taken the state directions and split it down into something that's a little bit more understandable by students. And we do that on a chapter by chapter. So the beginning of each chapter I give them what I call a cover sheet, and it's got the objectives and the standards, and all those things on there. It also includes things like vocab words and a little bit of background, like a tracker for the work that needs to be done in a particular chapter. So it's not, it's not just a list of tasks, it's all tied back to understanding. And my little gut check is if they can answer an essential question, they've earned their objectives and their meeting standards for the state. So they're all tied into one another.

Kristina: So basically they move from one objective to the next kind of a thing?

Brian: Yeah, so within a given time period…

Kristina: So like very day?

Brian: Yeah, within a given chapter we may have four objectives over like a three week chapter. So one that we were just doing, thermal energy, so looking at heat and how it is transferred. One of the objectives that they needed to demonstrate was that they know the difference between conduction, convection, and radiation. There are three methods of heat transfer, and they can show me any way they want. They can do that on a quiz or test, discussion, they can create a poster, they can make a video, you know, whatever, as long as they show me that they know what they're talking about so that I can report back and say, yes my students have achieved this standard, I'm good.

Kristina: And that might take, you know, like a week, like one week for a chapter?

Brian: Yeah, yeah, so.

Kristina: And what do you, they're like…

Brian: Oh go ahead, finish that question.

Kristina: Sorry. What if the students are at different, like one student is way ahead and you have another student that is way behind, how does that work out?

Brian: So that's where the flexibility comes in. The objectives, they just need to be met by the end of the semester. So like I said, I do schedule, you know, the last unit we did was about three weeks. So in those three weeks they needed to achieve those three objectives. If at the end of the unit, at the end of the test, they still haven't shown me, so if the student still could not explain those methods of heat transfer; conduction, convection. In the grade book I do put in a failing mark, but I can go back at any point and change that mark up until the end of the semester. And that's where the flexibility comes in. So at the end of the semester, or even a full chapter later, because all of these ideas, I spiral them so the earlier ideas layer, let me rephrase that. The ideas coming later in the semester layer on top of ideas we've already done. So they may build understanding on those base ideas as we're working on new concepts, and at that point, you know, if they can go back and say, oh I get it now, here's how it ties in with this and that here. Then I will go back and change that objective mark, because they've learned it. It just takes them a little bit, it wasn't within the three week, that's arbitrary, I'm not saying it's about three weeks to get this much stuff done. If a student falls outside of that window I'm okay with that, you know, now that we're getting into second semester, I can't go back and change the first semester grades, but they still have the freedom and they have the… the point is it all ties back to learning. So it's not so much I got a C because I didn't do these five worksheets, or I failed this test, or whatever. It's I got a C because I only learned two-thirds or three-quarters of the objectives I was supposed to learn, or of the learning I was supposed to do. So it's all going back to demonstrating the learning that happens day-to-day in the classroom.

Kristina: And that's totally up to the students?

Brian: Yeah, yeah.

Kristina: Basically.

Brian: And I can…

Kristina: Responsibility.

Brian: Yeah, I encourage them as much as I can, I'm there to support them and I'm there to help them, and I will sit down, we have before school and after school we have a study hall period, there's all different kinds of resources that are available that they have at their disposal to make themselves successful. But at the end of the day, they have to decide that they're going to do the work.

Kristina: Because if they don't, they'll fail.

Brian: Exactly, exactly. And it's tied back to the learning, you know, so that awkward question at the end of the, I'm sure you've gotten these questions about how can I raise my grade at the end of the semester. They look at the paper and they think, oh no. All of mine come back to, well can you explain this idea, this idea, this idea, and sometimes they say, oh yeah, this one was here, and I'll change the grade on the spot right there because they know, they've learned it, they should get credit for that. Other times, it's a very clear recognition of, no I don't know what that is. Okay, you know, that grade makes sense, I haven't learned it yet so why should I get credit. So it makes those conversations a little bit more lucid for the students, it's not so much which papers do I need to do. And it's also the same for parents, if I get contacted, or when I contact parents, you know, here's what your student has demonstrated to me, here's why their grade is the way it is, it's all based on the learning that they've done. It's much more defensible in my opinion.

Kristina: Because it's like, on a day-to-day, at least you know at all times what's their grade, like at any given moment, right?

Brian: Exactly, yeah, exactly.

Kristina: Okay. Yeah, so I've been spending so much time with applying it. So let me just go, now we're going to go through some questions just about I guess your definition, we're going to go backwards, because we started getting into. So now the general questions are basically, backgrounds of flipped classrooms real quick, what is your definition of flipped classroom?

Brian: Flipped classroom is teachers we're moving instruction from the community space, or the classroom space. I'm actually going to back up. It's removing… what's the way I want to say this? It's removing activity from the community space or the classroom space, they can be done individually. And so really what it boils down to is, is takes an instruction piece, do I really need to be the center of attention at the white board, or can this be something done individually by students? So flipping instruction is taking that individual component and putting it back on the students. And I'm very selective about when and where that happens, but the students have the opportunity to use individual time for individual learning and class time for group based community work.

Kristina: Okay. And what are your, what are your, in your experience, what is the main benefit, the benefits that you have found and what are the obstacles in the way that you've felt?

Brian: Benefits, students they, let's see, I think they develop more quickly as independent learners. They have a better understanding of what learning actually looks like, because it's not wrapped up in the school structures. I think it also empowers them to make decisions about how they learn. Everybody has preferences, whether or not those preferences are, you know, like the learning styles backed up by research or anything. But, you know, I prefer to do certain tasks, certain ways and if I can choose to do so, I will. I think drawbacks are it, I'm not only struggling with teaching my students science, I'm struggling with teaching them life skills. So it's a double edged sword. You know, where in a situation where I'm the center of attention teaching the class, all I have to focus on is the science and instruction. In this method where students have the freedom to make mistakes, whether that's a mistake around the content, or a mistake around their conduct, that's something that I have to deal with as a teacher. So it puts a lot more pressure on me to be lucid in the classroom at all times. They're very few days where I can just sit down, you know, and…

Kristina: So it's more work for you essentially.

Brian: Absolutely, absolutely it's much more work on my part. Now, and that goes for both sides of preparing material and in the implementation of the material. I think another drawback would be that we're, it's a good and a bad thing. I think it's a drawback because it takes energy, and that's changing the culture of the classroom, where students are more active in their learning role. It's benefit, because it's a good thing, I want my students to be active, especially in a high school level. But it's a drawback, because again, you know, it takes energy away from the content instruction. And honestly here in the states, that's how I'm measured is my content instruction. So there's, I've got this kind of bear on my back where I'm always aware that my students are going to be assessed for their content. And while personally I think their growth and development as adults is more important than physics, you know, people evaluate and say otherwise. So I'm trying to balance those two things. And I think a lot of teachers have kind of reached that point when they start to flip, is they start to feel that tension.

Kristina: But do you feel it's because of bad behavior and moral values like that?

Brian: No, no, no I don't think it's, nothing like that, I think it's, you know, they don't know, they've been forced to be responsible for their own learning. At least in my situations, I've never had a student who has come to me already understanding that it's their job to learn. I mean they understand that it's their job to do worksheets and be attentive. But they don't know what learning looks like and the struggle that has to happen. And so when they get frustrated, and they feel like they're struggling, they tend to shut down, rather than persevere. And so that's more what I'm talking about, is fighting that fight of confusion and using confusion to drive understanding in the long run. And that's what my job is in the classrooms, is to help them bridge that gap.

Kristina: Okay. So you might get them to do like more exciting activities, right?

Brian: Yeah, yeah. So we try to do more hands on things, help them see the connections, not just on paper, but, and that's what's nice about science, is that we can see these things happen in some cases. You know, but it works across, you know, history repeats itself, you know, we can look at, you know, the immigration crisis going on right now, and compare them to World War II, when

people were fleeing Poland and the Czech Republic, and then the spread of the Soviet Union to Eastern Europe, you know, other immigration crisis. Than there are cultural gaps that can be bridged by language right now, you know. Literature is growing again because of the Internet, people can publish. So I think they're a lot of different ways to tie in relevance. And you know, it started with science and math, kind of the Bergman and Sams thing in the science classroom, but I think we're starting to see it's more and more applicable as our world becomes more and more connected.

Kristina: Just a quick question, do you think that immigration at the moment, like to the United States?

Brian: Well I mean politically here it is. Yeah, I mean we've got, I don't know how much of American politics you follow, but we've…

Brian: Our big conversation right now has to do with Hispanic immigration. You know, so we have children and adults coming from Mexico used to be the big one, but now it's like El Salvador, Cambodia, because they're fleeing gang violence. You know, and so that's what we hear about a lot, but really the large boom we're seeing right now is in Asian immigration to the United States, and they're for different reasons. But you know, part of what I think working in a student centered environment can bring, is an opportunity to compare and contrast these different things, and how the media plays into it, and how culture plays into it, and how, you know, our role in democracies plays into that, and what our individual goals are. And in our classroom where I'm focused on giving them names and dates of people to remember and give me back on a test, you can't have those conversations.

Kristina: But in your, in a flipped classroom it has space for that?

Brian: Absolutely, yeah.

Kristina: Right. Which I was also going to say, I know you've talked about UDL and I've read also that you've done PBL, project based learning, what other pedagogical approaches do you use in the classroom?

Brian: I've started using more, it's called modeling instruction. That is, that was definitely more for the sciences. It started in physics, it's starting to be used more in biology and chemistry, but physics for the most part because it's so observable where students are given a situation, you know, so one that I'm getting ready to do with my students is we're starting electricity next week. So I'm going to ask them to light up a light bulb with a battery and some wires. So a very simple task, but they have to explain what's happening, and then we build on that. So if they can get one light bulb to light up, okay, now light up two light bulbs, and they try it and do it, and then they revise their model. And then you give them something that would, it's a compounding factor, so I would ask them to create a system where two light bulbs lit up, but I can take one out and leave the second one lit up. And it takes what they've already done, their current understanding, and it forces them to change it again. So their building the model of understanding around the principal. So I started to use that a little bit more.

Kristina: And that's definitely specific to the sciences, right?

Brian: It is, yeah. It's very hard to do, I tried it in biology a few years ago and that was even very difficult to do. So it works very well in physics and chemistry.

Kristina: Okay.

Brian: I still, there are some very, very accomplished physics modellers and there's a whole modelling community based on physics. There's published work and writing and all kinds of stuff if you're interested in just kind of seeing how it's applied more. But what's nice about it in my situation, is that when you're in a flipped environment is that they can go through this process and when they're ready to get some answers, you know, when they feel like they've got a model that works, they can pull up the video and they don't have to wait for me to wait for everybody to be

done. So they can kind of work at their own pace, they can get that feedback. But it's all based on the experience first, rather than replicating something they've already been told.

Kristina: Okay, that's interesting. Yeah, that's, it seems like the flipped classroom is really specifically very big with physics teachers I would say.

Brian: Yeah, I think it's an easy…

Kristina: I think that (**unintelligible),** right? Huh?

Brian: Yeah, it's an easy jump to make because of how hands on it is. And because of how much of a disparity there is in science learning. You know, we use, I have students who are very, very talented, and students who are struggling a lot, and then a lot in the middle. And that's what attracted it to me at first.

Kristina: Okay. Before we finish, I also noticed that, read that you were in South Korea. So I have to, I actually, I also taught in South Korea as an English teacher for a year. But yeah so, how did you start flipping there, or how is?

Kristina: And how was that?

Brian: I was at an international school in Seoul and that's where I was, it was my first year teaching. You know I graduated, got married, moved to Korea. So we really kind of went all in. And that's, you know, so that's a culture, and you know, it's highly, highly academic.

Brian: Especially in a private school with you know the big focus is on getting AP credits and the test scores and making sure all that happened. And as a first year teacher, I was like man, I'm in over my head because I was still learning how to teach, and figuring out my own methods and ways. So really at that point I was just really looking for help. And so, you know, when I talked about the AP students and helping them with their homework, that was great for me because I knew I was supporting them and their AP tests were fine, you know. I think that was the biggest culture shift because when I started flipping, I flipped with my general courses. So not AP students, just regular chemistry. And it was a big struggle for a lot of those students because especially in Korea, and if you've been there, you know, that they're very used to sitting and listening and taking notes and doing tests.

Kristina: Exactly.

Brian: So it was a big cultural shift, but I had a lot of support from my principal, and my assistant principal who saw the benefit in helping these students, especially the Koreans, the ethnic Koreans who had gone through the system, to try to expand them and get them ready for study abroad. A lot of them came to the states, a lot of them Europe, you know, and wanted to make sure that they had, had experiences in high school that would prepare them for, you know, good, rich learning experiences, not just test completion.

Kristina: And have, yeah, how did they react to that change? I know that you said the school was, how did the students react and the families react?

Brian: Yeah, students they struggled. It was hard. The ones, let me say it this way, I guess my ethnic Korean students struggled more than my international students. So kids who had lived in the U.S. or in Europe, or even, I had students from Africa, my African students, you know, a lot of the ones who were used to school as a community endeavor did better than my Korean students. So there was a big transition period. By the end of the year they were in to it, and they were doing great, and I was really proud of the work they were doing, everyone was learning and moving forward and it was awesome. And I think with the parents, there were some concerned parents, but like I said, I had a really strong administrative team and the parents I did talk to, I was able to win them over because I was showing them what their students were learning and doing. You know, I connected it back to achieving those objectives, make them prove that they've been learning. And those parents talked to other parents, who talked to other parents, so it was kind of network effort where, like at first there was some pushback, especially after some of the first test scores came out, because they struggle, you know, it was hard. But once we got into the flow of it,

I think it was really, really well accepted by the community, which was really encouraging for me, because I felt like I, you know, had done something right.

Kristina: Yeah, I think it also helps that you had a really, probably had a solid formation on the flipped classroom, and you had the process of flipping, right?

Brian: Yeah. And this whole time I had been emailing John and Aaron, and some others that I had made contact with, just because I was so young, you know, I was twenty-four and figuring things out and we were all kind of working, you know, John and Aaron were starting the mastery stuff around that same time so we were all kind of having the same struggles. So having the community to bounce ideas off of and support one another helped me form that process, the one I'm still using today.

Kristina: Right. Is that because of the formation you had provided that? Or do else, how does it work now for new teacher who wants to like, you know, learn to flip the classroom?

Brian: Yeah, that's a great question. I think, you know, we always, I always tend to start with the why, you know. I don't start with software skills, or video creation skills or anything like that. It's always about the why, and so whenever I'm teaching new people if I get asked to do a workshop or something, you know, we start with what they're familiar with. I always have people bring a lesson plan, or unit plan, and we break down the unit, we look at the curriculum, and we look at what they're doing. And then we move into, what if you took this piece out? What if you took that piece out? What would you do? And we have that conversation about how class is rearranged. And we talk about the process in terms of the context, you know, so it's not just this, oh you should use this thing, or that thing. It's always here's the piece that you've identified is something that would work well individually, how can you accomplish that now. So it's always task driven, it's not, it's very concrete in that way. So they have something that they leave a workshop with that they can use. And from there, they've gone through the process once and they can begin to apply and explore and expand on what they do to find something that works well for them.

Kristina: Yeah, but it's all about having them basically the formation of some sorts?

Brian: Yeah, you have to have an idea of what you're going for, an idea of the principals involved, you know. And that's something that the flipped learning network, you know, we try and provide for people, that's kind of that base level. But interpretation is everything, you know, somebody who's in a different school system than me with different students and resources, they have to interpret things differently than I do. So yeah, the foundation is important, but we want people to be able to expand and find something that works well for them.

Kristina: So the flipped network, so you recommend teachers to connect with the flipped network?

Brian: Yeah. We've got…

Kristina: You can find a community there?

Brian: Yep, yep, definitely find community there. You know, we've got workshops and things that run year round now, regional conferences, the big national conference, we're going to start up some webinar programming, things like that for the month to month. But we want people to feel like they, okay, so I talk about this process seven years in now, but really I do this and this, but you got to remember I floundered through a lot of these things. I made a lot of mistakes, I tried things that did not work well at all, and so I dropped them. It's a process, it takes time, you want people to feel like they can take time to develop something, rather than meet the level that I or a colleague might be at just because we've been doing it for so long. So finding a community, and the flipped learning network is one place to do that.

Kristina: Yeah, for sure. Alright, and the last question wrapped up is about future directions. So as you know, there's a lot of, anyways, so the flipped classroom is definitely very popular these days, many people are talking about it as a, you now, an option. The most popular of the blended

learning models. Do you think it's here to stay? Or do you think it's a passing trend as a teacher, what is your projection for the direction it's going to take?

Brian: I do think it's here to stay. I think it's unique in the sense that, it's a gateway, you know, flipping for me, when I started flipping I wasn't aware of all the different things that I could do in my classroom, because I had never been exposed to them. You know, so when I started flipping I said, oh I can do this, or I can do that, and I started to build and turn it into this thing that I run now in my classroom. I still consider myself flipped, but I don't know that I would say, you know, that's why it's not a methodology, it doesn't really stand on it's own. I think it helps me build out an effective learning program for my students. So I think it's here to stay in that sense, where we want people to take this idea, a very approachable idea. So let's, here's an example, if you're a college lecturer of twenty years, you know your stuff inside and out, you're an expert and somebody is encouraging you to try and change the way you do things, you're not going to jump into a project based learning or an inquiry model because you have no basis of understanding for that. Whereas a flipped environment you approach it as, oh I can record my lectures, where I am still giving the information, it's very comforting, and it's a step that somebody can take into something larger. Where now the information is recorded, do you just want to play the video in your classroom? Well of course not, because that's not effective anymore. It starts to open that window just a little bit so that you can take manageable bites of steps of improvement, and that's where I think the future of flipping is. Is in helping people understand that they can take what they're already doing well and expand on it in meaningful ways.

Kristina: So you're saying, it's a step-by-step process versus?

Brian: Yeah, it's very much a process, it's not so much that you flip a switch and you're done.

Kristina: Yeah.

Brian: Even this year I've tried things that haven't worked, you know, things that I thought would fit well within kind of this flipped method or flipped idea. And you know, the process of finding the good stuff and dropping the bad stuff. Yeah.

Kristina: Yeah, it seems to be very much of a kind of innovative thing for innovative teachers, not for a person who just wants to do the same thing as the safe way. You kind of have to be adventurous, right?

Brian: Right, right. But we don't want, and we don't want it to be unapproachable, right? We want people to feel like that they can't submit to it, and you don't have to be an expert in order to just try it out. So we're trying to tow that line a little bit, where you need to be forward thinking, but you don't have to already be that guy, you know, be the expert, or, you can be a learner as you go.

Appendix:
Written Interview with Dr. Ana Rita Mota

Questions for Dra Ana Rita Mota on the Flipped Classroom Teaching Model by Cristina Greene

Introduction

1) **Can you briefly introduce yourself and your professional experience and how you learned about Professor Eric Mazur /Peer Instruction/Flipped Classroom?**

I have a Bachelor's degree in in teaching Physics and Chemistry at the University of Aveiro and received his doctorate in physics in the Faculty of Science of the University of Porto, under the guidance of Professor João Lopes dos Santos.
After a conference on Physics Education Research, in Palermo, where I listened to the Eric Mazur talk about how combined Peer Instruction and Flipped Classrooms a methodology called Team & Project-based Approach, I was excited and wanted to go to work with him at Harvard.
In 2015/2016 I worked at Harvard University, with Eric Mazur's research group. I also worked as his assistant professor (coordinator) in the course Applied Physics, known by the methodology Team & Project-based approach. At Harvard, I was also an assistant professor (coordinator) from the physical David Keith.
I am the author of articles published in national and international journals and have as main interest for research the areas of collaborative education, evaluation and metacognition.
Currently i am a researcher post-doc at the Department of Physics and Astronomy of FCUP (Porto University- Faculty of Sciences). In addition, an elementary and highschool chemistry teacher since 2005.

2) **What was the most valuable thing you learned about Peer Instruction/Flipped Classroom when you worked as an assistant of Professor Eric Mazur?**

It is difficult to answer this question, since these two ideas were incorporated in the Team & Project-based approach. Probably I would say that the most surprised me was that students learn better with each other than with teachers (because they can be cognitively more active in pair discussion). Plus the fact that the classroom is flipped encourages students to take responsibility for their own learning

Definition

3) **Many argue the FC is not a methodology, but merely a way to be more efficient with class time. What is your definition for the Flipped Classroom?**

To answer this question I would have to be more familiar about what is and what is not considered a teaching methodology. Thus, through the perspective of a teacher (and not researcher) I would argue that this can be considered a methodology and is not restricted only to an enhancement of classroom time. It is much more than that, especially if accompanied by other methodologies such as the Peer Instruction. Is the ability for the students to be co-responsible for their own learning and become more autonomous.

4) **Are you familiar with the other models of Blended Learning or Flipped Learning before this experience?** No.

5) **Describe your teaching style/pedagogy before your experience in Boston Flipping the Classroom.**

Mainly lectures combined with constant evaluation (by holding weekly questions in class) and with a weekly laboratory, using the lab stations model. In the laboratory classes, students practiced Peer Instruction, and engaged in a variety of collaborative tasks

Application

6) **What results did you observe the first time in terms of student learning in the Flipped Classrooms you observed in Harvard University?**

What surprised me the most was to see students totally engaged discussing Physics (with one another) enthusiastically. This scenario is quite different to other classes that have I attended at Harvard where students were limited to listening to the teacher.

7) **I understand Dr. Mazur prefers giving reading material to students vs video lectures for preparation before class. Can you explain how reading is more beneficial than online lectures for science students vs other subjects, in a world where digital is so dominant? Do you agree? What were the students' reaction?**

Eric's choice has to do with the fact that students should develop skills related to the ability to learn how to study from a book. It is not therefore considered that "reading is more beneficial than online lectures for science students", because students naturally go to online resources when they are working on projects! His goal is to have students use both tools, and that is why he divides them into distinct sections of the course (reading material for the preparation of classroom and online tools for the realization of projects or other tasks).

8) **In your experience/observation, how did the Flipped classroom/Peer Instruction/Team-based Learning change the role of a teacher?**

These methodologies enabled the creation of greater accountability to the students, as well as more preparation work for the teacher. During class, the teacher assumes the role of a guide or monitor. In order for student to be more responsible for their learning, the teacher must put a lot more thought into class preparation.

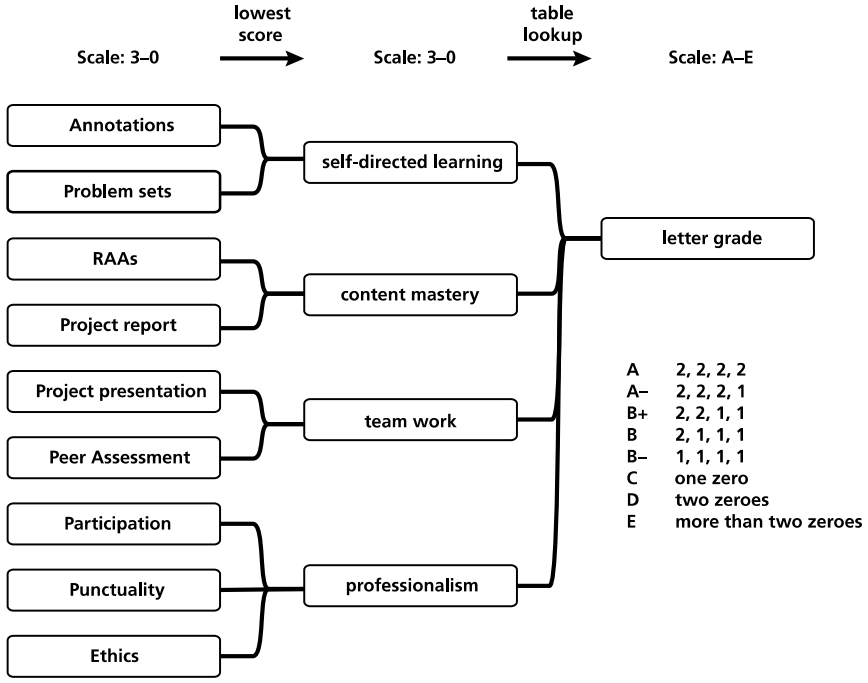
9) **Did you observe more than one pedagogical approach in one class (i.e) Team-based learning, Problem-based Learning, Peer Instruction, Just in Time? How did that play out in class, you could provide a short description?**

Yes, the Team & Project-Based Approach is a methodology which brings together all the previous assumptions. Building a model of this kind requires a considerable team of teachers and researchers working for quite some time. For this reason, it is not easy to implement the model quickly and easily in other contexts. On the other hand, the partial implementation of the methodology can also put the operation at risk.

Assessment

10) What kind of assessment is adopted in Peer Instruction? How was the Readiness Assurance and Just in Time teaching/Quizzes work? Can you describe how it worked out in the Peer Instruction classes? How do the students react to it?

The model for the evaluation of Team & Project-based approach is very complex, so it is difficult to explain it in a few words. However, the main idea is that students are constantly being evaluated (in a semester students are more than 50 assignments!) in different tasks (in the sense of being evaluated in the different skills). Another important idea is the Peer Assessment. It is important that the assessment is also made by their peers. The following diagram explores the evaluation of this course:



This system is quite complete and complex, but very inspiring at the same time.

11) How do you keep track of the assessment of all students at same time in class? Can you explain how Perrusal, Socrative, Learning Catalytics worked in the assessment and in general? Were any other digital tools/resources used?

Harvard University has a system of management of students (CANVAS) where the grades of each student are placed and where they can see their average throughout the semester. The LC is a platform which only gives the scores of students in the RAAs and Perusall gives the scores in the annotations. Socrative is not used at Harvard.

Pros and Cons

12) **In your personal experience, what conditions do you need to Flip the Classroom? What preconditions are favorable? Unfavourable?**

The Flipped classroom works well if they had a set of complementary methodologies (such as Peer Instruction) and if students are constantly being evaluated so that the teacher has a constant feedback from the course. If this does not happen, students may feel completely lost, because there is no conducting line. The materials developed by the professor should take into account the fact that the class is flipped.

13) **Based on your observations, what are the main obstacles that schools/students to implementing the flipped classroom? What are the biggest advantages in flipping the classroom and do you find that the pros overweigh the cons?**

As I said before, there are two inconveniences- on one hand, the teacher/instructor must create mechanisms that ensure that the student has prepared at home; on the other, material must que developed in order to complement this methodology. The main advantage is that the students can be cognitively involved in class, because they already have some base knowledge of the material. On the other hand, it allows the teacher to develop other competencies which students cannot develop on their own.

Tips

14) **To your knowledge, what preliminary preparation was necessary for you to Flip the classroom (in terms of class organization, preparation, awareness of student, and families)**

The implementation of this methodology is not difficult. The teacher /instructor must just ensure that students prepare at home. To this end, a system of assessment must be implemented for each assignment. It may be through an online platform such as Perusall or by asking a question at the beginning of each class regarding the material assigned.

15) **What advice or tips would you follow in your future classes, as well as for schools and teachers attempting to flip for the first time?**

The most difficult part is for the teacher to ensure that the student has done the pre-class preparation at home. To do this, he must evaluate the homework assignment. Trusting in the students' word is not sufficient. If the students are not assessed, probably they will not prepare at home!

16) **For those flipping for the first time, how do you recommend deal with resistance among students? Parents? Faculty? Administration?**

The impact of these methodologies in higher education is proven by tens of investigations, which would not have problems to justify its application. During the application process, I would seek to have a constant feedback from students and make the necessary adjustments for students used to the traditional classroom.

17. **What is a bad flipped classroom in your eyes? How can it be improved?**

It will be a class where the teacher still continues to lecture in class, even after the students have prepared at home… In this context, students will not be involved in cognitively and there is no incentive for students if they continue preparing at home.

Future Directions

18. What future perspectives do you see for the flipped Classroom? Do you think it a temporary trend is it here to stay?

As I said, I think that Flipped Classroom has great potential and is here to stay! However, this methodology alone may not bring significant advantages to learning. It needs to be complemented with other methodologies- pedagogies that promote the involvement of cognitive students during classes.

19. Do you think it could be successful in Portugal? In Europe

Yes, without a doubt.

Appendix:

Written Interview to Dr. Idalina Sousa

1. How and why did you decide to try out his the Flipped Classroom Model in your classes?

As a teacher and researcher in the area of Sciences of Education and Educational Technology i always try to keep abreast of the "news" of new methodologies. And, as I belong to some groups (real and virtual) who work in these areas will have knowledge of what is done by the world outside.

However, I first became aware and curious the Flipped Classroom approach at a congress I attended in London. I frequently hear the comment: "the school is from the 19th century, the teachers are of the 20th century and the students of the 21st century." However, this does not make any sense! I think that we should keep up with technological changes in order to provide them with a school more appealing. I believe that we must follow new trends and provide students with new contexts for teaching and learning. I always have been open to innovative pedagogies and would not fail to do so now.

2**. What were the reasons that led you to try a new approach to teaching?**

When I read about this methodology, it immediately made me think that it would be a great way to motivate students' learning, make them more responsible, more autonomous and that would be a way to individualize the support they need. In a nutshell, it could provide them lessons and different learning contexts in which I feel that there is greater space for student involvement. We are always lamenting that official school programs are very extensive and, to a certain extent, this methodology might help to minimize this situation.

3. What subject do you teach, and what are your student levels?

The area in which I have worked is to mathematics. Soon I will expand this methodology to other areas of the curriculum because this is transversal. The Flipped Classroom has been applied in various levels of education, from basic to secondary where the contents are adequate. We must have this care! This methodology, as others should be rethought… instructors must keep in mind the type of content that is taught and must adapt the materials to the particular level of education they are teaching.

4. How were your classes organized and what kind of advance preparation was necessary to make?

All students received, in advance, the materials that should prepare before class. It is usually easier to send an e-mail or save the material in a pen drive (as a way to ensure that everyone has equal access to materials). This study assumes the acquisition of basic knowledge, and to this end, videos are sent, notes are taken of sites, different types of presentations are shared… all this accompanied by a small study guide. Each student will understand and work at their own pace… the instructor merely provides a guideline to help students develop good study habits and working methods.

The beginning of class is the time for the teacher to clarify doubts (if any) and after students begin to work in pairs, small groups or individually if they so wish. An activity that greatly motivates students has been the use of the different applications – apps. Activites that have a game component are preferred. However, different materials can be used. The objective is to reserve class time for activities that require higher thinking skills and application of knowledge. After class, the students can always review the materials submitted in advance and thus consolidate their knowledge.

5. What kind of pedagogical activities are used in the classroom (e.g. active learning, work project, etc)

As I said earlier, I prefer the use of apps because they still foster more their interest in participating in the classroom. But, other materials may be used, such as worksheets, the activity book, the student book, etc … This methodology is well suited for both pair work and/or group work or project- and always using active learning.

6. In particular, what preparation was made for the students?

Students are advised that they will be sent an email with the materials that must be addressed and the type of work that will be done in class. Sometimes, when apps are required for class, it is asked to bring their mobile devices, following the trend of Bring Your Own Device (BYOD - and to do an online registration (on websites), if so required.

7. What resources were used, and with what respective objectives?

As I mentioned, I use videos, notes from websites, different presentations and even textbook pages, if necessary. These are very important for the purpose of acquiring basic knowledge at home.

The use of apps (which may include games) in the classroom actually increase student motivation and involvement ... even the weaker students study at home to be able to participate in activities with apps.

8**. What problems and difficulties did you experienced when implementing the Flipped Classroom?**

To ensure that all students have equal access to study materials. The biggest problem/difficulty is access to the Internet at school. Sometimes the activities take a little longer to start due to technical problems.

8. How did you overcome those difficulties?

For everyone to have equal access to materials, it is necessary to know who has access to the Internet at home in order to save the materials on a pen drive for students who do not have internet access at home. The problem of Internet access at school (signal strength) is resolved by changing rooms or even by moving to the library… it is interesting how the change of physical spaces can make the difference.

9. What results were obtained in student learning?

There has been an improvement in the formative assessments results and, more than that, the knowledge/ experience of working in groups- more respect and autonomy. The interaction with the digital resources significantly increases the involvement of students in their own study.

10. What modes of assessment were used?

The use of apps in class activities facilitates access to student responses, since there is an immediate record of assessment. The Flipped classroom allows the teacher to keep greater track of student records, which facilitates the continuous evaluation. I am currently working with two more colleagues from different schools and decided to apply a pre-test, an assessment test and a post-test. We want to assess the quantitative results in order to verify to what extent the classes in which this methodology is applied leads or not to better results. It is clear that new forms of assessment should be found, but this aspect still requires some care because of official school assessment criteria.

11. What impact did this strategy have at an institutional level?

The impact is felt bit by bit. This approach requires a greater investment of time from the teacher and this is not always possible. I note that this methodology begins to excite some teachers when they notice it favors some aspects of teaching and learning. Even because it is very well accepted by the students.

12. What are the benefits and obstacles that felt after the implementation of the class reversed?

So far I have only found benefits… more responsibility, it's the best way of being in the classroom and in group work, less indiscipline and much more student involvement. Some teachers complain about the amount of prep time it involves.

13. What do you think is the future direction of the Flipped Classroom?

It is a methodology that will continually gain more enthusiasts and that significantly alter the way teachers teach and that, certainly, will modify the strategies and methods of evaluation. The studies conducted all over the world have presented numerous advantages. Students becomes more active and is without a doubt the center of the classroom. The classes are less expository and the teacher is able to monitor each student work much more closely.

Appendix:
Written Interview with Mr. Marc Alan Sperber

Introduction

17) **Can you briefly introduce yourself and your professional experience and how you decided to be an instructional designer**

I'm currently a Creative Design Lead at EdPlus at Arizona State University where my focus is creating new partnerships and educational models with the goals of increasing access to education for non-traditional students while advancing the ways in which technology could improve the teaching and learning experiences. Prior to this, I spent close to a decade at Duke University in the capacity of an educational technologies and instructional design consultant where I helped to build and improve online and residential programs with a focus on developing faculty members' pedagogical expertise and their use of instructional technologies.

My path towards instructional design was a long and windy road. After publishing a music magazine, doing market research related to healthcare advertising, editing TV commercials, and getting experience in K-12 classrooms, I realized my passion was a cross between the psychology of learning and how media and technology could influence the ways in which people think. My first thought was that I would become a media literacy researcher and educator. However, after landing a foot-in-the-door position at Duke University as a multimedia specialist, I quickly earned my master's degree in instructional technology and distance learning administration, and the rest, as they say, is history.

18) **How did you learn about and start flipping, and why did you choose this approach/model?**

I first started researching flipped classrooms when writing a grant proposal to transform medical education in Tanzania. Our focus was an institution that had faculty who could often not make it to the classrooms to teach because they were needed by patients in the clinics. When they could make it, they would simply read text off of years-old PowerPoint slides. While there were many technological, language, cultural, and resource barriers, we figured out a way to utilize a Duke University learning management system (LMS), Duke video-recorded lectures, new IT staff and technologies, and nearby partners who were able to train and mentor faculty and facilitators on how to use these and additional resources to flip their classrooms. This allowed students to review the content on their own time and to discuss and apply their knowledge in the classrooms.

Definition

19) **Many argue the FC is not a methodology, but merely a way to be more efficient with class time. What is your definition for the Flipped Classroom?**

The flipped classroom is not, by itself, a methodology. A flipped classroom *could* allow teachers to have more time to engage students, but it does not, by itself, guarantee that students will be more engaged or that a class will be any better. There are many ways to flip a classroom and I've seen good examples of it, and some very bad examples.

There is nothing new about students having to acquire knowledge outside of the classroom and hopefully having a chance to discuss it in class. Likewise, the concept of active learning is not new. It may a buzzword as of late; however, it is not the opposite of "traditional" teaching. Teaching that asks students to acquire knowledge and then does not give students a chance to know whether or not they understood it, to discuss it, to think about it, to apply it, that's not "traditional" teaching, that's bad teaching.

To me, a good flipped classroom contains always contains formative assessment, discussion and debate between students, feedback and targeted instruction on the trouble spots, and real-world problem solving. This is very different than what I hear some people saying about the flipped classroom, which is that students simply do their homework in class.

20) **Are you familiar with the other models of Blended Learning**?

Yes. Too many to mention here.

Application

21) **What results did you have after the first time in terms of student learning? What pedagogies do you find have the best/worst results in student learning? What impact did it have on your institution?**

My first experiment with the flipped classroom did not go well. I was working with a faculty member who did not listen to much of my advice. Everything I thought would go wrong, did go wrong. The students revolted and again, against my advice, the faculty member told students that the quizzes they were receiving on the videos and readings would not count toward their grade. From then on out, most students did not watch the videos outside of class, in-class discussions were not good, and it all fell apart from there. After this, I was able to speak with more authority to other faculty, not only citing the literature, but citing my own experience.

In my experience, finding a way to hold students accountable for their out-of-class work is essential. Generally, this is best accomplished by starting class sessions with a low-stakes assessment. It doesn't have to count for much, but it has to count. I've also found that students can often times better answer their classmate's questions than teachers. Faculty are often so advanced in their thinking of the content, they have trouble remembering to explain some of the fundamentals like a novice would. Therefore, it is important that the in-class experience builds in time for this type of discussion between students. Beyond the basic understanding of content, what the flipped classroom can achieve better than a traditional classroom is the development of students' critical-thinking and problem-solving skills. To do this, teachers should present small teams of students with real-world problems that force students to make a decision and to be able to defend that decision.

While the flipped classroom – when done right – certainly improves student learning and has certainly won the hearts of many faculty and students, there continues to be just as many who dislike this approach. Simply put, it's more work. More work for faculty to design their courses, and more work for students – especially those who have been able to get away with not doing required readings outside of class.

22) **How did the Flipped classroom change your role as a teacher**?

Given my experience, I now believe that every single teacher should be doing some degree of a flip.

23) **What pedagogies do you use with your freed class time? (i.e. Team based learning, PBL, etc) Do you integrate more than one pedagogical approach? Why do you choose them?**

My preferred model of the flipped classroom is Team-based Learning (TBL). Not simply students sitting in teams, rather, the Larry Michaelsen TBL model. By following the TBL model, teachers apply many of the evidence-based principles of effective teaching.

24) **What preliminary preparation was necessary for you to Flip the classroom (in terms of class organization, preparation, awareness of student, and families)**

Research, training, discussion with peers, practice, and mentorship.

25) **How does instructional design apply to the flipped classroom?**

Good instructional design is essential for any course, not just a flipped classroom. Knowing what technological resources are available to the instructor and how to use them, knowing about students' prior experience and knowledge, aligning assessments with learning objectives and course content, these are things that all teachers must take into account when designing a course.

26) **What advice or tips do you have for schools or teachers attempting to flip for the first time?**

Do some research, get some training, find a mentor, have on-going discussions with peers, practice, and be willing to fail, learn, and try again.

27) **In your personal experience, what conditions do you need to Flip the Classroom? What preconditions are favorable? Unfavourable?**

Faculty have a much higher chance of success when flipping a classroom if they have support from an experienced instructional designer and a network of peers with whom they could share experiences. Their chances of success are also higher if they spend a significant amount of time prior to the start of the semester redesigning their course and preparing for the first day of class where they introduce the approach to students. Deciding to flip a class mid-semester is generally a recipe for disaster. It also helps when students have more than one teacher using the flipped approach.

28) **The Flipped Classroom isn't for everyone- to what group/category do you think it is best fit for?**

The flipped classroom can work for any faculty member who gets to spend time some face-to-face or real-time virtual time with students, in any discipline, as long as they have – or can fake – the confidence to stick it out. This is assuming that students are receiving a grade, or credit, for their successful completion of the course.

29) **Do you find that it works better with certain subjects than others? i.e) languages vs the sciences?** No.

Assessment

30) **What kind of assessment do you adopt? How does it work? How do the students react to it?**

I like to see a mixture of formative and summative assessment, with an emphasis on regular, timely formative assessment and feedback. This can accomplish two critical things, 1) it can hold students accountable for reviewing out-of-class content, 2) it can illuminate knowledge gaps, which can reduce instructor lecture-time from 100% content-coverage to the small fraction still requiring clarity.

I'm a fan of the TBL approach to formative assessment, an individual followed by a team assessment – using the same questions for both assessments. Individually, students are held accountable for preparing for class. As a team, they learn from one another, as they debate which multiple-choice answers to select. By the time this process is done, students are ready to move to the higher levels of learning, by applying their knowledge.

It takes time for students to get used to the idea that they will be assessed on content that has not yet been covered during an in-class lecture. They'll complain that it is not fair and ask why they are paying for an education if they have to teach themselves. Of course, what students don't realize is that 1) they are often receiving an equivalent to the in-class lecture, outside of class prior to the assessment, 2) they are often provided with significantly more feedback and discussion-time than in a traditional class, 3) instructors are not being lazy, in fact their workload can at least triple when they decide to flip a course like this, 4) instructors are doing this because the evidence in the learning sciences make it clear that students will learn more – the instructors who are doing this care about teaching, and care about their students.

31) **How do you keep track of the assessment of all students at same time in class?**

They best way that I've seen to do this is to use the quiz feature within a learning management system (LMS). Immediately after students are done with the time-limited quiz, an instructor can see how students did on each question.

32) **What digital tools/ resources did you use? Why and how do they work?**

As with all educational technologies, the tool should be determined by the learning objective and type of activity. With that said, two technologies that could be used in nearly all TBL courses is a learning management system for the distribution of digital content and individual assessments and a paper-based IF-AT scratch-off card for team assessments.

Pros and Cons

33) **What are the possibilities and most important benefits of Flipping the classroom? What limitations does it have?**

The fact that most of us receive formal education by the way of lecture makes me wonder if we are on the wrong side of an alternate universe – it seems very dystopian. It reminds me of an assembly line, of cattle lined up at a trough for feeding time. A lecture hall may have been an efficient way to disseminate knowledge before textbooks, but it is not at all reflective of the way people will have to learn and use knowledge in the real world.

The flipped classroom is a step in the right direction. It puts students in the position where they have to become more responsible for their learning, teach their peers, provide and receive performance feedback from peers, defend what they think is correct based on what they have learned, and make decisions that professionals in the field have to make.

34) Were you successful the first time you flipped? What problems/obstacles/difficulties did you feel the first time?

35) How do you deal with resistance among students? Parents? Faculty? Administration? For students used to the traditional classroom

Partial transcript from my Cengage podcast on flipping the classroom:

> *That's a great strategy. I've recommended something similar before… and it works. I especially like the part about students having a say in how their final grades are determined. But, you know, I recently read about a strategy that I like even more. I've been recommending it, and it's also been working… so I want to share it here.*
>
> *In what you described, you're telling your students, "Listen to me, I know what's best for you. You'll learn more this way." And your goal is to get students to buy-in to the approach. But, this article I read gives that type of example and likens it to a parent telling their little kid, "Listen, spinach is healthy; you'll eat it because it's good for you, and you'll like it." Well, they may eat it, but that doesn't mean they'll like it, or they won't complain about it.*
>
> *So, this guy's approach is to pretty much use the Socratic method to eventually lead the students to say for themselves that it's more important for them to learn how to address real-world problems in his course than it is to memorize facts. Then he says, "Okay, if this is our goal, let's think about the different parts of the learning process" - like reading, listening to lectures to learn the base concepts, working on and discussing problems, getting feedback, etc. - and he says to them "tell me, what of these things do you think you could do on your own outside of class?... and what of these things do you think you'd want to do in the classroom to meet your goals?" Lo and behold, the students sell themselves on the flipped approach. And, there you go. Student buy-in.*
>
> *Either way… both of these approaches seem to work. The takeaway here is that some careful and deliberate effort has to be put into the student buy-in process. Students will resist most active learning approaches because it's more work than sitting there listening to a lecture.*

*a***What is a bad flipped classroom in your eyes? How can it be improved**?

If a teacher is simply having students do homework in class and having them watch lectures outside of class, that is an example of a bad flipped classroom. The goal of a flipped class should be to move beyond knowledge acquisition, recall, and practice and feedback.

Future Direction

20. What future perspectives do you see for the flipped Classroom? Do you think it a temporary trend is it here to stay?

In the future, as computing devices are more capable of sifting through information to provide humans with answers to complex questions, learning will have to become more experiential – outside of a classroom, more interdisciplinary, and more design-oriented in nature. In other words, students will not be presented with a lesson or case study and told to answer questions with same-discipline classmates. Instead, they will test hypotheses in the real world, in virtual interdisciplinary teams, by creating, testing, and refining prototypes of their solutions. Learning by doing, it's as old as learning how to build a fire by rubbing sticks together.